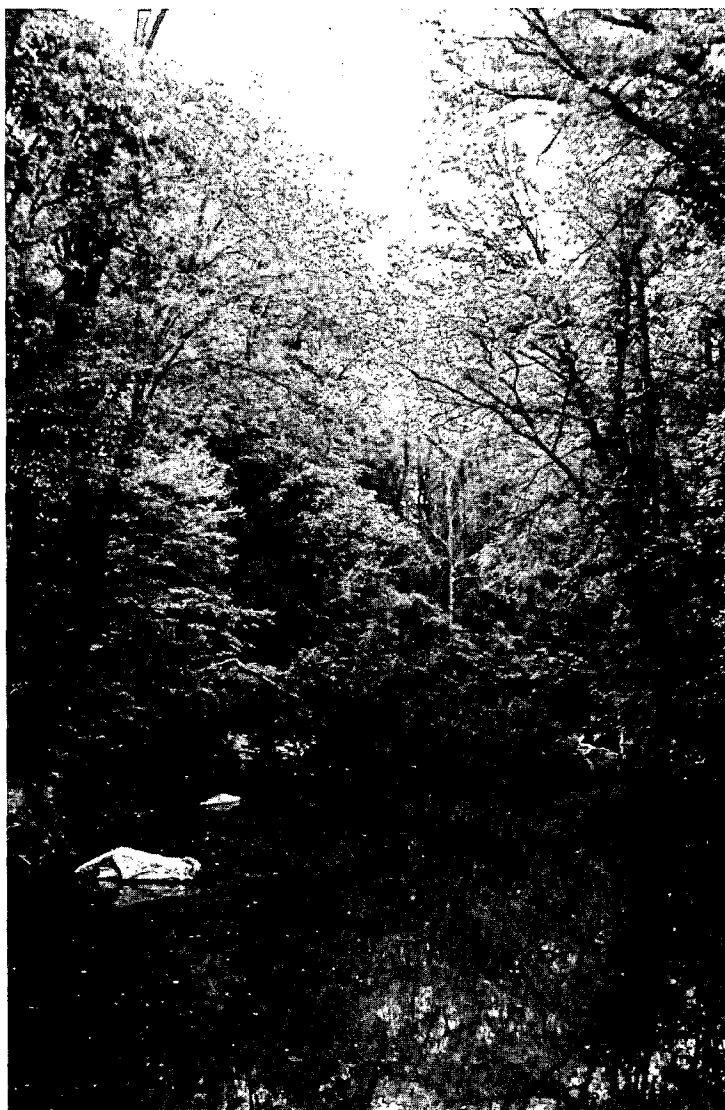


are . Coastal Zone Management Program



# Recreational Potential of the Christina River

**CZIC COLLECTION**

New Castle County  
Delaware

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1981

Delaware Office of Management, Budget, and Planning

## ACKNOWLEDGMENTS

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William J. Cohen, AICP

Frank R. Selby, Coordinator of Research

Andrew D. Zimmerman, Senior Associate

RECREATIONAL POTENTIAL  
OF THE CHRISTINA RIVER

New Castle County, Delaware

1981

Prepared By: William J. Cohen and Associates, Inc.

Prepared For: Delaware Office of Management, Budget, and Planning

U. S. DEPARTMENT OF COMMERCE NOAA  
COASTAL SERVICES CENTER  
2234 SOUTH HOBSON AVENUE  
CHARLESTON, SC 29405-2413

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177 E. DELAWARE AVENUE, NEWARK, DELAWARE 19711  
(302) 453-8881

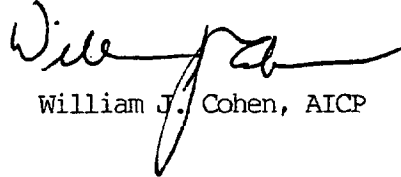
June 1, 1981

Mr. David S. Hugg, III  
Acting Director  
Office of Management, Budget, and Planning  
Townsend Building  
Dover, DE 19901

Dear Mr. Hugg:

I am transmitting to you the final feasibility report relative to the Recreational Potential of the Christina River as commissioned by the Office of Management, Budget, and Planning. We have attempted to take a practical perspective, evaluating the potential for recreational activities on this urban river in New Castle County. We trust that State, County, and Municipal agencies will find this study useful and we further hope that through these efforts the people will find greater recreational opportunities on the Christina.

Sincerely yours,



William J. Cohen, AICP

WJC:1kn

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## OVERVIEW

The main stem of the Christina River has its headwaters in Pennsylvania, flows into Cecil County, Maryland, and enters Delaware at the State line just north of Newark. The river meanders south through the City of Newark; across I-95 to Cooch's Bridge at Old Baltimore Pike; is met by two tributaries, Muddy Run and Belltown Run near Salem Church Road; moves northerly and forms Smalley's Pond; runs through the Village of Christiana at Rt. 7; joins with the White Clay Creek at Bread and Cheese Island; flows north-west through the Town of Newport; meets the Brandywine Creek at Wilmington then the Port of Wilmington, and finally terminates at the Delaware River. This waterway covers a total of 30.3 miles in the State of Delaware.

In the early spring of 1981, responding to interest expressed in evaluating the recreational potential of this river, the Delaware Office of Management, Budget, and Planning commissioned a study to be undertaken that would do the following:

1. identify publicly-owned property and access points
2. analyze existing data regarding river characteristics
3. review land use and recreational plans as they relate to recreational development
4. identify potential recreation uses and sites
5. make recommendations for potential recreation area designations

Furthermore, it was determined at the outset that the study would focus on potential recreational use capability on existing publicly-owned lands, utilizing existing public access points, thus reducing the need for new land acquisitions. It was also desirable that the study would serve a wider purpose of educating the general public about the recreational potential of the river so that additional opportunities, within easy reach of the States' most populous urban concentrations could be made available.

Over three decades ago, the esteemed Delaware Valley historian, C. A.

Weslager wrote:

Its quiet, brackish waters are wide and deep enough to permit entrance of ocean-going steamers, but it is truly unpretentious in appearance. There is no city, town, forest, or park at its mouth, and no scenic beauty to arrest the sight-seer and lure him upstream to seek its source. No songs or epic poems have been written about it, and few outside of its marshy valley recognize it by name. Even those living near its banks today are scarcely aware of the part it played in the lives of their forebears and the impression it has made on their folkways.<sup>1</sup>

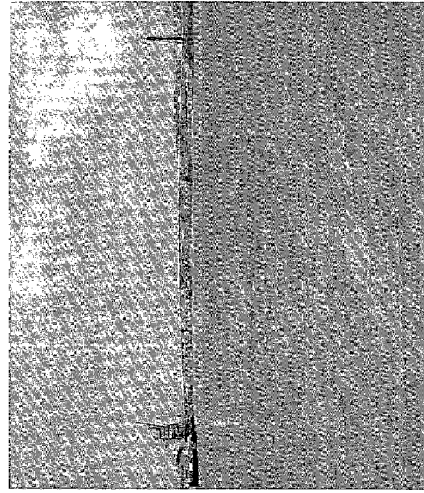
On a hopeful note, the information presented in this study will encourage others to seek "its source" and to enjoy the many advantages that this urban river has. In effect then, the forgotten Christina River should be re-discovered.

#### Visual Highlights

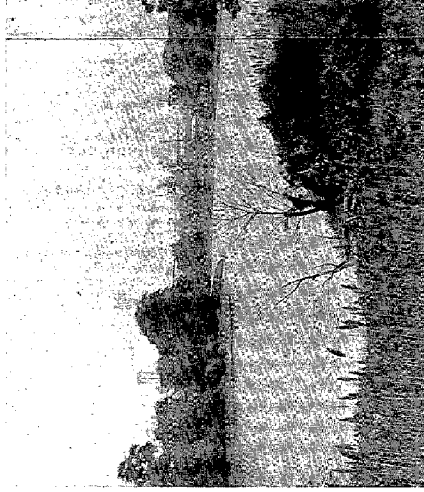
The River's visual characteristics are varied, depending on where one views its shores. The following page highlights the changing environment that can be observed along the Christina.

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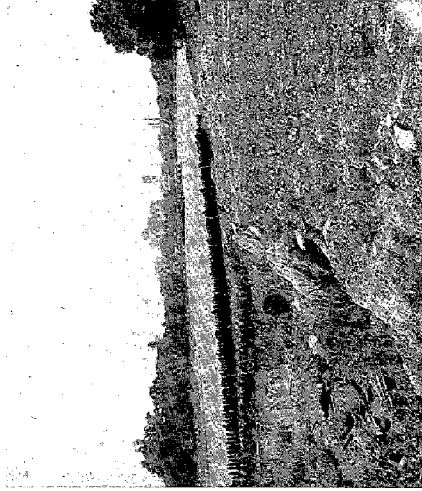
<sup>1</sup> Delaware's Forgotten River: The Story of the Christina (Wilmington: Hambleton, Inc., 1947), p. 3.



1. The mouth of the Christina  
at the Delaware River



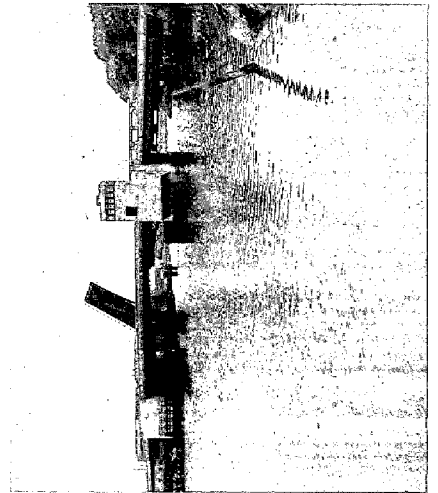
4. From Interstate 495  
near Newport



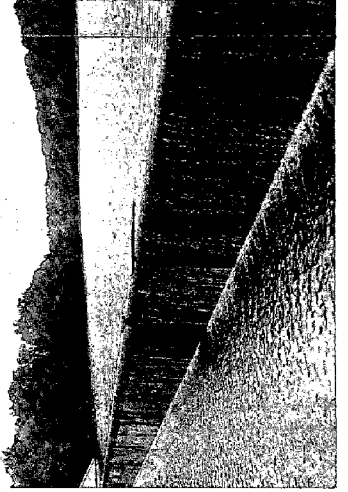
2. East 7th Street Park  
Wilmington



6. Cooch's Bridge  
near Newark



3. 3rd Street Bridge  
Wilmington



5. Smalley's Pond

## Visual Highlights The Christina River

## New Castle County Delaware 1981

## SETTLEMENT PATTERNS

### Historic Sites

The Christina River shoreline includes a number of historically significant buildings and locations. Fort Christina in Wilmington--the landing place of the Swedes in 1638--and the Cooch's Bridge Historic District near Newark, prominent during the Revolutionary War, are heavily visited by tourists each year. The Christiana Historic District represents one of the oldest settlements in the State, dating from 1685. Table 1 provides an inventory of historic sites on the Christina, and they are shown on Figure 1.

The locations on the River of Cooch's Bridge, the Village of Christiana and Fort Christina can provide a network for both tourist interest as well as recreational activity in visiting historic sites.

Table 1

## HISTORIC SITES

## Christina River Shoreline

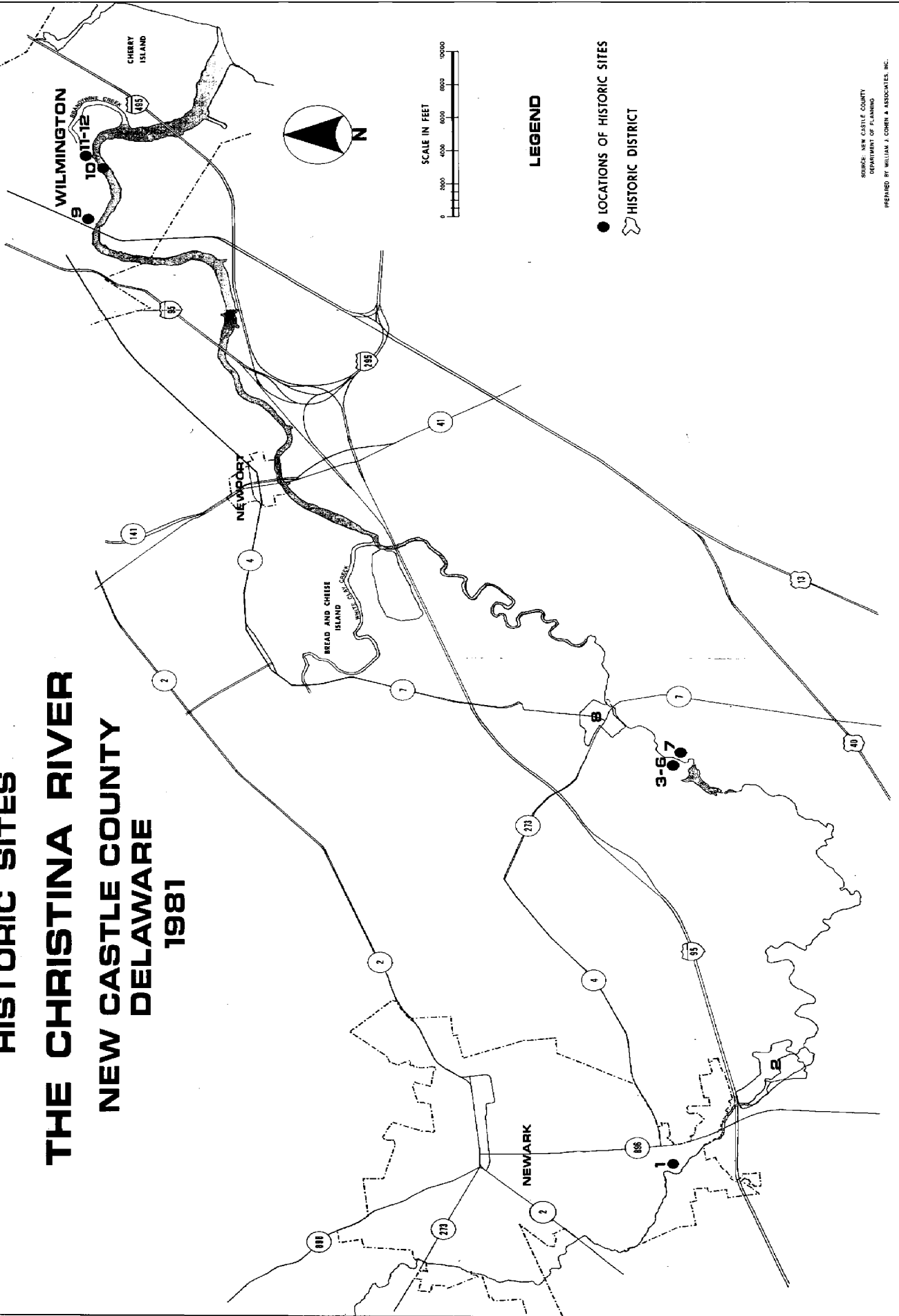
Number	Name	National Register	Ownership	State Inventory Number	Remarks
MID-LATE EIGHTEENTH CENTURY					
1	Andrew Fisher House	Yes	Private	N-263	Includes the following: N-1469 Cooch House N-1467 Patterson Hill N-1487 Bayard House/Armstrong House N-1468 Dayett Mill N-1470 Dayett House
2	Cooch's Bridge Historic District	Yes	Private	N-190	
3	Christiana Pumping Station	No	Private	N-3999	
4	J. A. Kendall House	No	Private	N-4000	
5	Wm. Fox Smalley House	No	Private	N-3998	
6	Alexander Foster's Grist Mill	No	Private	N-193	Demolished--Site only
7	60 Smalley Dam Road	No	Private	N-4032	
8	Christiana Historic District	Yes	Private	N-1475	In particular, these two properties are adjacent to the Christina: N-197 John Lewden House N-1475.30 23 Water Street

Table 1, continued

Number	Name	National Register	Ownership	State Inventory Number	Remarks
TWENTIETH CENTURY					
10	Third Street Bridge	No	State	N-1071	
SEVENTEENTH CENTURY					
11-12	Fort Christina	National Historic Landmark	State	N-338	
	Thos. Bird House/John Stalcop Cabin	Yes	State	N-359	

Source: Delaware Preservation Checklist (1974)  
Records, New Castle County Department of Planning

# **FIGURE 1** **HISTORIC SITES** **THE CHRISTINA RIVER** **NEW CASTLE COUNTY** **DELAWARE** **1981**



SOURCE: NEW CASTLE COUNTY  
 DEPARTMENT OF PLANNING  
 PREPARED BY WILLIAM J. CORNELL & ASSOCIATES, INC.

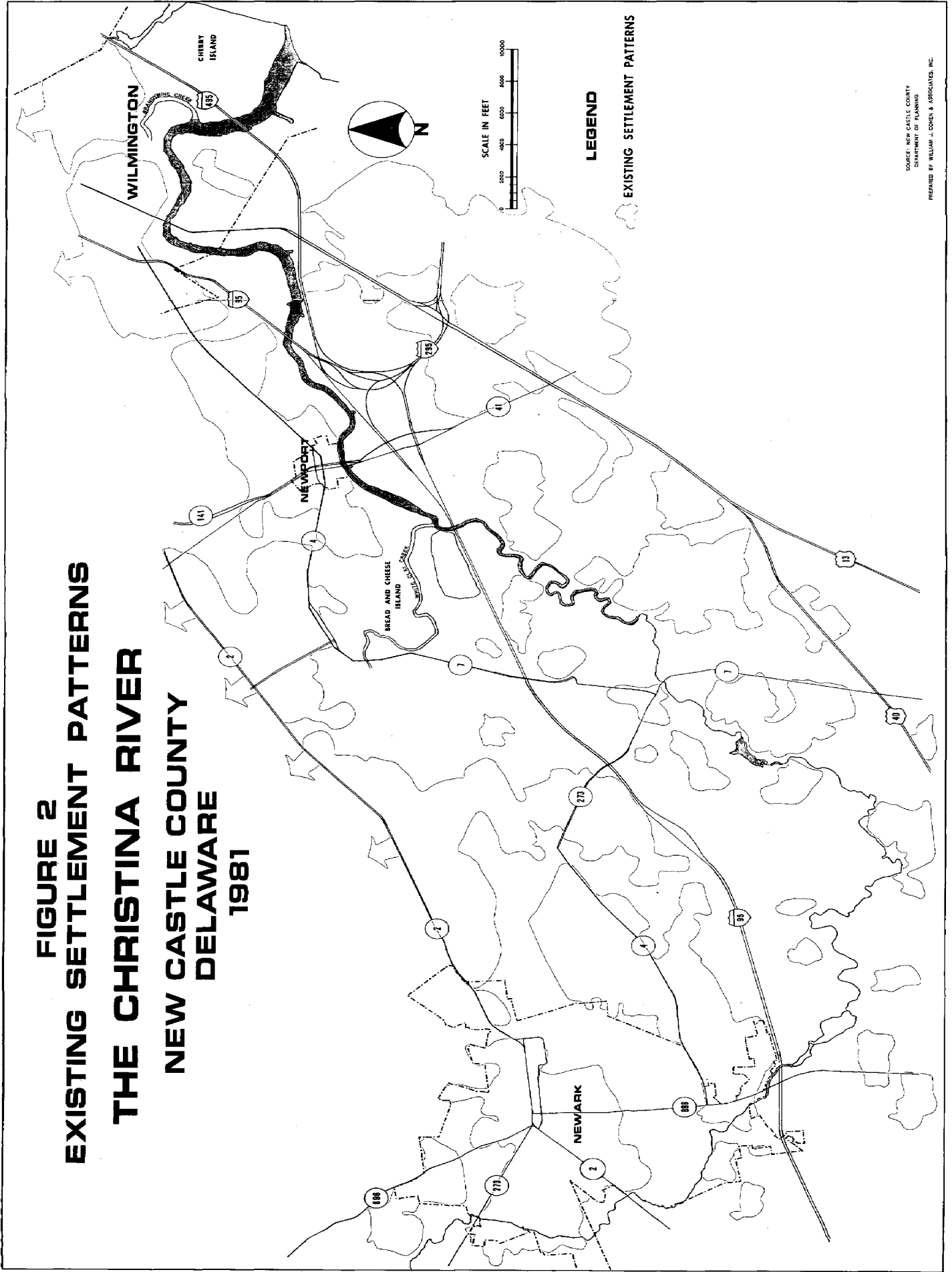
### Existing Settlement Patterns

The pattern of settlement contiguous to the Christina River, as in most of New Castle County, has been toward increasing decentralization or "suburbanization" in recent decades. For example, the population of the City of Wilmington, which represented nearly one-third of the County population in 1960 had declined to less than one-fifth of the County population in 1980. The other two incorporated municipalities along the Christina, Newport and Newark, display different trends. The population of Newport has changed little during this period, while the population of Newark has increased 2½-fold. Much of the growth of the Newark area has been represented by expanding suburban-type housing developments, covering an ever-widening area. This trend is illustrated in Figure 2, Existing Settlement Patterns. As shown in Figure 2, the settlement pattern is exceptionally dense north of the Christina, except between Newport and Rt. 273. South of the Christina the densest settlement patterns occur in Newark, along Rt. 7, and in the New Castle area.

The concentration of residential subdivisions along the Christina shoreline and vicinity has increased. These subdivisions are situated between Newport and Rt. 896. Approximately 14 residential subdivisions currently exist in this area, nearly all of which represent recent construction.



**FIGURE 2**  
**EXISTING SETTLEMENT PATTERNS**  
**THE CHRISTINA RIVER**  
**NEW CASTLE COUNTY**  
**DELAWARE**  
**1981**



# PUBLIC LAND OWNERSHIP: CHRISTINA RIVER SHORELINE

The entire length of the Christina River from the Maryland state line to the Delaware River--a total of 30.3 miles--includes a great number of property owners, both private and public. Public ownership is defined for this study as any land area that is contiguous to the Christina River which is owned by any unit of government. The Federal government, State government, New Castle County government, and the municipalities of Newark, Newport, and Wilmington, all own parcels of land abutting the Christina River, under the auspices of various agencies and departments.

The tax assessment records for New Castle County provide the names of property owners for all assessed parcels of land. Other land ownership along the Christina River shoreline occurs in the form of State Highway Rights-of-way land. Appendix 1 provides a complete listing of all assessed parcels of land on the Christina River and the owner of each parcel. Table 2 summarizes this information. Figure 3 Public Lands provides a graphic reference and distribution to various ownership levels along the River.

Table 2

## OWNERSHIP OF ASSESSED PARCELS

### Christina River Shoreline

Hundred/City	Total Parcels	Publicly-Owned Parcels		Total Acreage	Publicly-Owned Acreage	
		No.	(%)		No.	(%)
Wilmington	83	20	(24.1)	724.73	414.28	(57.2)
Newport	14	3	(21.4)	58.58	24.12	(41.2)
Newark	44	11	(25.0)	262.55	131.25	(50.0)
New Castle Hund.	81	12	(14.8)	1175.75	294.88	(25.1)
White Clay Cr. Hund.	56	4	(7.1)	2214.29	43.70	(2.0)
Christiana Hund.	9	3	(33.3)	623.33	165.46	(26.5)
Pencader Hund.	17	1	(5.9)	971.64	2.00	(0.2)
TOTAL	304	54	(17.8)	6030.87	1075.69	(17.8)

Source: Real Estate Atlas of New Castle County, Delaware. (Seventh Edition: 1980) Miami, Florida: Real Estate Data, Inc., and William J. Cohen and Associates, Inc.

Tables 3 through 6 document the publicly-owned land according to the individual ownership categories. It should be noted that the only Federally-owned land along the Christina River is found in Wilmington; and the only County-owned land is found in New Castle and Christiana Hundreds.

Table 3

FEDERALLY-OWNED LAND

Christina River Shoreline

Hundred/City	Total Parcels	Federally-Owned Parcels		Total Acreage	Federally-Owned Acreage	
		No.	(%)		No.	(%)
Wilmington	83	3	(3.6)	724.73	164.78	(22.7)

Source: Real Estate Atlas of New Castle County, Delaware. (Seventh Edition: 1980)  
Miami, Florida: Real Estate Data, Inc., and William J. Cohen and Assoc. Inc.

Table 4

STATE-OWNED LAND

Christina River Shoreline

Hundred/City	Total Parcels	State-Owned Parcels		Total Acreage	State-Owned Acreage	
		No.	(%)		No.	(%)
Wilmington	83	8	(9.6)	724.73	12.93	(1.8)
Newport	14	2	(14.3)	58.58	0.50	(0.9)
Newark	44	1	(2.3)	262.55	34.29	(13.1)
New Castle Hund.	81	7	(8.6)	1175.75	130.11	(11.1)
White Clay Cr. Hund.	56	4	(7.1)	2214.29	43.70	(2.0)
Pencader Hund.	17	1	(5.9)	971.64	2.00	(0.2)

Source: Real Estate Atlas of New Castle County, Delaware. (Seventh Edition: (1980)  
Miami, Florida: Real Estate Data, Inc., and William J. Cohen and Assoc. Inc.

Table 5

## COUNTY-OWNED LAND

## Christina River Shoreline

Hundred/City	Total Parcels	County-Owned Parcels		Total Acreage	County-Owned Acreage	
		No.	(%)		No.	(%)
New Castle Hundred	81	5	(6.2)	1175.75	164.77	(14.0)
Christiana Hundred	9	3	(33.3)	623.33	165.46	(26.5)

Source: Real Estate Atlas of New Castle County, Delaware. (Seventh Edition: (1980) Miami, Florida: Real Estate Data, Inc., and William J. Cohen and Associates, Inc.

Table 6

## MUNICIPALLY-OWNED LAND

## Christina River Shoreline

City/Town	Total Parcels	Municipally-Owned Parcels		Total Acreage	Municipally-Owned Parcels	
		No.	(%)		No.	(%)
Wilmington	83	9	(10.8)	724.73	236.57	(32.6)
Newark	44	10	(22.7)	262.55	96.96	(36.9)
Newport	14	1	(7.1)	58.58	23.62	(40.3)

Source: Real Estate Atlas of New Castle County, Delaware. (Seventh Edition: 1980) Miami, Florida: Real Estate Data, Inc., and William J. Cohen and Associates, Inc.

Table 7 accounts for all publicly owned land on the Christina River Shoreline, indicating the relationships among the various forms of public ownership.

Table 7

## TOTAL PUBLICLY-OWNED LAND

## Christina River Shoreline

Hundred/City	Publicly-Owned Parcels	State-Owned		County-Owned		Municipally-Owned		Federally-Owned	
		No.	(%)	No.	(%)	No.	(%)	No.	(%)
Wilmington	20	8	(40.0)	0	-	9	(45.0)	3	(15.0)
Newport	3	2	(66.7)	0	-	1	(33.3)	0	-
Newark	11	1	(9.1)	0	-	10	(90.9)	0	-
New Castle Hundred	12	7	(58.3)	5	(41.7)	NA		0	-
White Clay Creek Hund.	4	4	(100.0)	0	-	NA		0	-
Pencader Hundred	1	1	(100.0)	0	-	NA		0	-
Christiana Hundred	3	0	-	3	(100.0)	NA		0	-
Total	54	23	(42.6)	8	(14.8)	20	(37.0)	3	(5.6)

Source: Real Estate Atlas of New Castle County, Delaware. (Seventh Edition: 1980) Miami, Florida: Real Estate Data, Inc., and William J. Cohen and Associates, Inc.

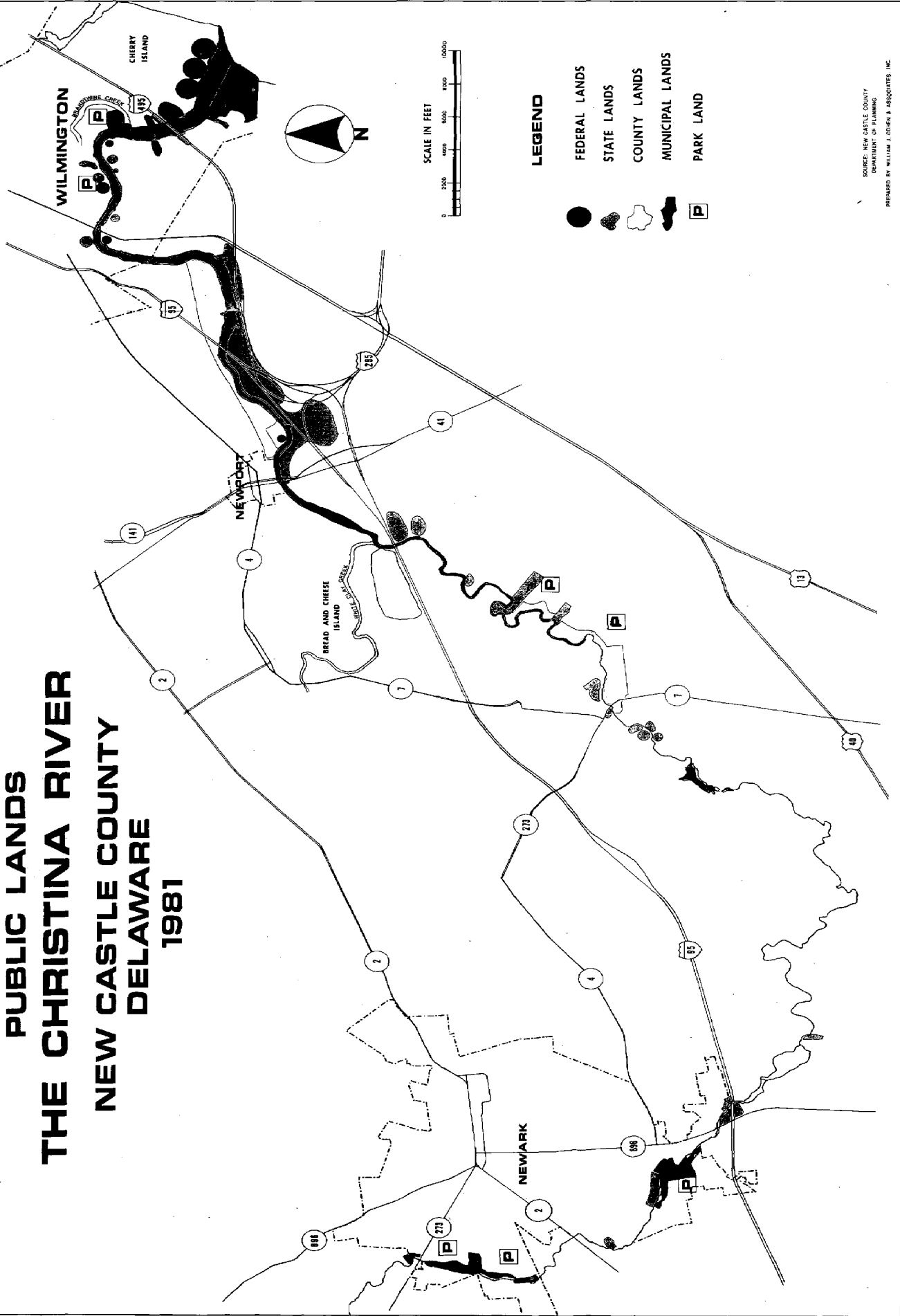
Table 7

Continued

Hundred/City	Publicly-Owned Acreage	State-Owned No. (%)	County-Owned No. (%)	Municipally-Owned No. (%)	Federally-Owned No. (%)
Wilmington	414.28	12.93 (3.1)	0 -	236.57 (57.1)	164.78 (39.8)
Newport	24.12	0.50 (2.1)	0 -	23.62 (97.9)	0 -
Newark	131.25	34.29 (26.1)	0 -	96.96 (73.9)	0 -
New Castle Hundred	294.88	130.11 (44.1)	164.77 (55.9)	NA	0 -
White Clay Creek Hund.	43.70	43.70 (100.0)	0 -	NA	0 -
Pencader Hundred	2.00	2.00 (100.0)	0 -	NA	0 -
Christiana Hundred	165.46	0 -	165.46 (100.0)	NA	0 -
Total	1075.69	223.53 (20.8)	320.23 (30.7)	357.15 (33.2)	164.78 (15.3)

Source: Real Estate Atlas of New Castle County, Delaware. (Seventh Edition: 1980) Miami, Florida: Real Estate Data, Inc., and William J. Cohen and Associates, Inc.

**FIGURE 3**  
**PUBLIC LANDS**  
**THE CHRISTINA RIVER**  
**NEW CASTLE COUNTY**  
**DELAWARE**  
**1981**



In addition to these identified parcels, some land abutting the Christina River is part of the State Highway Right-of-Way. Nearly all of this land is found at two locations: at the Delaware Turnpike Interchange at Route 896, and along the south bank of the River north of I-495 between the Wilmington City line and the Town of Newport. Also included are smaller parcels of land which have been acquired by the State for proposed Newark Beltway and Christiana Bypass Rights-of-Way. State Highway Department Rights-of-Way records provide an indication of the extent of these land holdings. The amount of shoreline acreage may not be precise due to the difficulty of aggregating a number of small, in many cases not contiguous parcels. Records indicate that these State Right-of-Way lands comprise approximately 600 acres.

Another aspect of Christina River shoreline land ownership is land which is part of approved subdivisions that has been dedicated as public open space according to the Record Subdivision Plans. There are five such subdivisions along the Christina River. In addition, one proposed subdivision is in the planning stage and an exploratory sketch plan has been filed with the County Department of Planning, which if approved, would provide another parcel of open space/parkland. Table 8 provides a listing of all dedicated open space in existing and proposed subdivisions in New Castle County as of May 1981.



Table 8

## DEDICATED OPEN SPACE FROM RECORD SUBDIVISION PLANS

May 1981

## Christina River Shoreline

Subdivision Name	Location	Dedicated Open Space	Remarks
The Woods	White Clay Creek Hund.	46.25 ac.	1.56 ac. private above 100 year flood line; 6.18 ac. public above 100 year flood line; 38.51 ac. public below flood line
River's End	New Castle Hundred	74.23 ac.	17.06 ac. private 57.17 ac. public
Taylortowne	New Castle Hundred	70.23 ac.	4.65 ac. private 65.58 ac. public
Wellington Woods	New Castle Hundred	46.78 ac.	
Heather Woods	Pencader Hundred- along Belltown Road	7.53 ac.	
Barrett Run*	White Clay Creek Hund.	39.8 ac.	31.8 ac. open space 8.0 ac. active park-land
Total	----	284.82 ac.	----

\*Proposed

Source: New Castle County Department of Planning

One additional unique category of land ownership along the Christina shoreline that should be included in this discussion is owned by public utility companies operating within the County and including Delmarva, Artesian Water Company and Wilmington Suburban Water Company. Although these land holdings fall within the

domain of privately-owned land, some of this land offers the potential for public recreation, especially if it is contiguous to public land. Often a utility company will be required to purchase an entire parcel of moderate or substantial size to locate a small substation or other facility. Therefore, the remainder of the parcel is retained as open space and is not utilized. Table 9 identifies the parcels and acreage owned by utility companies along the Christina shoreline.

Table 9

## PUBLIC UTILITY COMPANY LAND OWNERSHIP

## Christina River Shoreline

Hundred/City	Parcels Owned By Utility Companies		Acreage Owned By Utility Companies		Number of Parcels Containing More Than 5.0 Acres
	No.	(%)	No.	(%)	
Wilmington	5	(6.0)	84.20	(11.6)	4
Newport	1	(7.1)	0.20	(0.3)	0
Newark	0	(0.0)	0.0	(0.0)	0
New Castle Hundred	5	(6.2)	67.14	(5.7)	3
White Clay Creek Hund.	3	(5.4)	615.67	(27.8)	3
Christiana Hundred	1	(11.1)	14.32	(2.3)	1
Pencader Hundred	2	(11.8)	111.19	(11.4)	2
Total	17	(5.6)	892.72	(14.8)	13

Source: Real Estate Atlas of New Castle County, Delaware. (Seventh Edition: 1980)  
 Miami, Florida: Real Estate Data, Inc., and William J. Cohen and Associates, Inc.

As shown on Table 9, 13 of the 17 parcels owned by public utility companies include more than 5 acres. The largest such parcel, owned by the Artesian Water Company, contains 515.77 acres. These parcels merit consideration, on a case-by-case basis, relative to public recreational potential.

### Existing Public Park and Recreation Areas

There are currently 5 public park and recreation areas along the Christina River. Two of these areas are found in Wilmington, two in Newark, and one at Christiana. The latter, Coventry Ridge/Lewden Green Park is maintained by New Castle County and is by far the largest of the five areas. It is also the most extensively equipped and developed. The two areas in Newark are primarily in their natural condition, with few man-made facilities. The two Wilmington facilities comprise small parcels of land and are also essentially undeveloped. The East 7th Street Park, in fact, consists only of a parking area used by persons whose boats are launched into the Brandywine Creek or Christina River at that site.

The inventory of existing public park and recreation facilities is provided in Table 10 and these areas are shown on Figure 3.

Table 10  
EXISTING PARK AND RECREATION AREAS  
New Castle County, Wilmington, and Newark

Park	Ownership	Acreage	Current Facilities and Activities
East 7th Street Park	City of Wilmington	6.80	undeveloped--contains a parking area only; boat launching into Brandywine Creek
Christina Park	City of Wilmington	11.19	softball field comfort station (closed) drinking fountain (inoperative) pavillion other improvements planned (including parking)
Coventry Ridge/ Lewden Green Pk.	New Castle County	164.77	1 softball field 1 Little League field 2 tennis courts 2 basketball courts playground equipment area swimming pool bath house parking for 30 cars
Rittenhouse Pk.	City of Newark	52.55	hiking and nature trails picnic tables shelter parking
Stream Valley Open Space	City of Newark	31.89	Undeveloped--left in a natural state

Sources: New Castle County Department of Parks and Recreation  
Newark Department of Parks and Recreation  
Wilmington Department of Parks and Recreation

## PLANS AND POLICIES AFFECTING RECREATIONAL USES OF THE CHRISTINA RIVER

A series of planning documents and recreation studies have been reviewed to determine an overall perspective for the potential for future recreational use of the Christina River. In addition, the crucial elements of state legislation which would directly affect use of the Christina River have been reviewed. The pertinent policies and findings are summarized below:

### Regional

#### 1. National Urban Recreation Study: Philadelphia-Wilmington-Trenton Area.

(1977) Bureau of Outdoor Recreation, U.S. Department of the Interior.

This study analyzes the adequacy which present recreation facilities have toward meeting recreation needs. The research determined that, "Increases in programs and facilities have rarely kept up with increasing leisure time and interest and concomitant demand for recreation opportunities."<sup>2</sup> Planning officials and recreation directors were interviewed to identify recreation programs that were desired by their constituents but were not available because of a lack of physical or financial resources. For New Castle County, the greatest activity need which was identified was for motorboating. The study also noted that the amount of open space available for recreation activity was incapable of meeting demand and should therefore be maximized.

### State

#### 1. Delaware Tomorrow Commission Report. (1976)

Two of the policies developed by the Delaware Tomorrow Commission in recommending a statewide plan for growth would have a bearing on future land use policies for the Christina River:

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<sup>2</sup> National Urban Recreation Study-Philadelphia/Wilmington/Trenton. Washington DC: Bureau of Outdoor Recreation, U.S. Department of the Interior. 1977; p. 107.

First, Delaware should continue protection of coastal and estuarine areas throughout the State.

Second, Delaware<sup>3</sup> should strengthen programs to protect natural and man-made resources.

2. Delaware Coastal Management Program (CMP). (1979) Delaware Office of Management, Budget, and Planning.

The CMP offers many general policy guidelines for land use and resource conservation in coastal and shoreline areas. The CMP Policies for Recreation and Tourism include these two specific guidelines:

1. Government promotion of recreation and tourism, particularly in coastal areas, should be based on a study of their costs and benefits to Delaware residents. Recreation and tourist development that results in unnecessary or excessive expenditure of tax dollars for the benefit of a few individuals or groups should be discouraged.
  2. Year-round recreational and tourism programs and facilities are encouraged in order to reduce the reliance on summer-time recreation.<sup>4</sup>
3. Delaware Statewide Comprehensive Outdoor Recreation Plan. (1979) Department of Natural Resources and Environmental Control.

The Statewide Comprehensive Outdoor Recreation Plan (SCORP) identifies the largest physical resource deficits and opportunities for recreation in the City of Wilmington and the remainder of New Castle County. Nearly all of the identified physical resource deficits involve uses which could be a part of land and water recreation development, especially athletics, bicycling, and swimming. Table 11 indicates the ten largest physical resource deficits, as identified by SCORP.

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<sup>3</sup> Report of the Delaware Tomorrow Commission

<sup>4</sup> Delaware Coastal Management Program and Final Environmental Impact Statement. Dover, DE: Delaware Office of Management, Budget, and Planning. 1979; p. 5-D-5.



Table 11

RANK OF PHYSICAL RESOURCE DEFICITS

Wilmington and New Castle County

	<u>Rank</u>	<u>Wilmington</u>	<u>New Castle County</u>
High	1	scenic driving miles	biking trails
	2	biking trails	scenic driving miles
	3	playgrounds	playgrounds
	4	natural swimming areas	swimming pools
	5	tennis courts	natural swimming areas
	6	picnic tables	tennis courts
	7	football/soccer fields	football/soccer fields
	8	baseball/softball fields	picnic tables
	9	swimming pools	hunting and gunning areas
Low	10	hiking and nature trails	baseball/softball fields

Source: Delaware Statewide Comprehensive Outdoor Recreation Plan. (1979)

As shown by Table 11, athletics represents a significant portion of the recreational resource deficits. For both Wilmington and New Castle County, four of the ten deficits (tennis courts, playgrounds, baseball/softball fields, and football/soccer fields) are for athletic facilities.

4. Report of the Governor's Task Force on Marine Recreation in Delaware. (1980)

A portion of this report is devoted to identifying sites of potential value for marine recreation. The one Christina River site identified in the analysis is the North (right) Bank of the Christina River between the mouth of the Brandywine Creek and the Fort Christina Marina. This stie includes a 6.8 acre parcel owned by the City of Wilmington that has potential for expanded marine facilities or boat launching. According to the Task Force report, public access for

fishing and crabbing would be possible if the shore were bulkheaded. The following recommendation is formulated:

The site appears well suited to public recreation, as it is in the City and provides access to the Delaware River. However, city officials are not anxious to develop another park since the city budget is already strained. Officials would prefer to generate some income from the property by leasing portions to concessionaires while still providing public access to the water. An ideal solution might be to<sup>5</sup> lease the land for expansion of existing private marina facilities.

5. Critical Areas. (1980) Draft recommendations submitted to the Delaware Office of Management Budget, and Planning.

As part of its study of Critical Area in Delaware, the Office of Management, Budget, and Planning (OMB) has received recommendations from units of local government for inclusion as critical areas. New Castle County has recommended major rivers (including the Christina), shorelines, and waterfronts as scarce/unique. Also nominated were areas of major tourism value and existing and potential bicycle paths, due to economic benefits. The City of Newark has nominated the Christina River Open Floodway (Zoning) District as environmentally sensitive land. This includes the entire length of the waterway within the city limits. The Town of Newport nominated the entire length of the Christina River within its limits. The City of Wilmington nominated the Port of Wilmington, including the Christina River from the Delaware River to the City Line, citing this area as the state's major commercial shipping facility and an area of major public investment. Finally, the Delaware Department of Natural Resources and Environmental Control has nominated the Christina River as a critical area since it is used as a drinking water supply source and has social and economic significance. In summation, virtually the entire length of the Christina River has been nominated as a critical area.

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<sup>5</sup> Report of the Governor's Task Force on Marine Recreation in Delaware. 1980; p. 29.

## County

1. The Market for Water-Based Outdoor Recreation Service in New Castle County, Delaware. (1966) Paul H. Seidenstat , University of Delaware Water Resources Center.

This study also analyzes the demand for recreation activities and the need for additional facility development. Projections were developed for participation (annual activity days) in five popular outdoor activities through 1980, based upon continuation of the same resource capacity and pricing mechanisms. The projections indicate steadily increasing participation in all activities. Additional projections were developed based upon actual preference patterns, which accounted for participation rates assuming a lower cost to the user, better availability/convenience, etc. These projections were based upon assumed additional demand for outdoor recreation being manifest in out-of-state recreation trips. These projections also indicate steadily increasing annual activity days, especially for fishing and swimming. The study formulated this conclusion with respect to recreation supply:

With these impressive demand projections even on the basis of present facilities and prices, supply may now be and certainly will in the next decade be inadequate to meet this demand for practically all kinds of outdoor water based recreation activities.

2. New Castle County 1985 Planning District Plans. (1973-1974) New Castle County Department of Planning.

The only New Castle County District Plan which includes a recommendation for recreation use of the Christina River shoreline is the Greater Newark Planning District Plan (1974). In this Plan, a District Park (defined as 30-75 acres) is proposed for the site southeast of the Amtrack rail line, along Persimmon Run

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<sup>6</sup> Seidenstat, Paul H. The Market For Water-Based Outdoor Recreation Service in New Castle County, Delaware. Newark, DE: University of Delaware Water Resources Center. 1966; p. 45.

in Pencader Hundred and the City of Newark. This proposal was previously proposed in the City's Comprehensive Development Plan.

3. Coventry Ridge/Lewden Green Park Master Plan. (1974) New Castle County Department of Planning.

This plan encompasses a regional park totalling 154 acres. The Coventry Ridge Section (75 acres) was dedicated as public open space for parkland in the subdivision record plans of four adjacent subdivisions. The Lewden-Green portion (78.6 acres) was purchased by New Castle County in 1969.

Development plans called for full-scale development in 5 stages, resulting in full public use by 1980. The plans included facilities such as basketball courts, baseball and softball fields, picnic areas, bicycle and pedestrian pathways, play apparatus, a boathouse, senior citizens' areas, landscaping, maintenance and drainage facilities, etc. The first sector, including the former Coventry Swim Club, has been completed. However, according to the New Castle County Department of Parks and Recreation, implementation of the final 4 stages of development has been delayed, pending adequate funding.

4. New Castle County Natural Areas Study. (1975) Delaware Nature Education Society.

One parcel of land encompassing the Christina River was nominated as a natural area in this study. This area, referred to as "Christina Creek Banks and Marshes," includes approximately 225 acres, located on both banks of the Christina Creek between Churchman's Road and Route 7. The area is described as, "the last remnant of the once extensive Christina marsh system, which, prior to 1915, was one of the most attractive areas for waterfowl in Delaware. The balance of the area has been lost through filling and construction, hence that which remains merits a very high priority for preservation."<sup>7</sup> The area is the

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<sup>7</sup> Delaware Nature Education Society New Castle County Natural Areas Study, 1975; p. 125.

habitat for many species of plant and animal life; with air quality described as very good, and water quality described as fairly good but visually unattractive due to turbidity caused by siltation runoff. The study suggests that that portion of the creek would serve as an ideal canoe trail. Although launching is difficult, access could be provided at Punchbowl Woods (now the Coventry-Ridge-Lewden-Green Park) or below Churchman's Road Bridge. The study further cautions that future construction in adjacent areas must be sensitive to marsh destruction.<sup>8</sup>

5. New Castle County Bikeway Plan. (1979) New Castle County Department of Planning.

One proposed bikeway is included in the New Castle County Bikeway Plan for the Christina River shoreline area. The route, known as Christina River Trail, was proposed some years prior to the Bikeway Plan to follow a sewer right-of-way already established. However, the route was never implemented. It is now included as a Phase 2 planned project and is scheduled for implementation between 1982 and 1986. The route will cover 4.0 miles between Christiana and Airport Road. Part of the route will be a bike path totally separated from motor vehicle traffic. The remainder will be a shared roadway. In addition, other routes included in the Bikeway Plan would intersect the Christina, thereby creating a potential access point for bicyclists. These routes are:

1. Route 7--Christiana Mall to Christiana
2. South College Avenue--Route 4 to I-95
3. Elkton Road--Maryland State line to Newark city line
4. Route 273--Christiana bypass
5. Churchman's Road--Route 4 to Route 273

#### Municipal

1. Cherry Island Urban Design Study. (1969) University of Pennsylvania

This study, although done several years ago, presented a series of conceptual plans for mixed use development on Cherry Island and the adjacent peninsula of

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<sup>8</sup> Ibid; p. 127.

east Wilmington. Development of much of this area for recreational activities was a prime consideration. One set of recommendations urged the use of land unsuitable for development as open areas for parkland, picnic areas, athletic fields, and related activities. Another set of recommendations called for major marina development, including expanding existing facilities for boating and swimming, and developing, on Cherry Island, a complex to include a motel, restaurants, cultural attractions, amusements, and various open space attractions. The design plan stresses the importance of using recreational facilities to serve as an attraction to the area, to encourage new residential development and with the development of proper transportation linkages, to fulfill the needs of area residents, especially inner city residents, for a major recreation area.

2. City of Newark Comprehensive Development Plan (1969) Volume II. Kendree and Shepherd Planning Consultants.

This plan recommends the development of parkland in the southeast portions of the City, in the vicinity of Arbour Park. The City of Newark has already, since the adoption of its Comprehensive Development Plan, assumed control and operation of the Rittenhouse Park area. It was also recommended that, "vacant floodplain lands on the northwestern edge of the Arbour Park neighborhood be also designated as part of the community park area. The Christina Creek floodplain can link the two large park areas, forming a substantial city recreation area as well as a land use buffer separating industrial from residential lands."<sup>9</sup>

3. Urban Route Bicycle System, City of Newark. (1973) Newark Planning Department.

None of the proposed bikeway routes in the City of Newark will run along

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<sup>9</sup> Kendree and Shepherd Planning Consultants, City of Newark Comprehensive Development Plan. Part II. 1969; p. D-5.

the Christina shoreline. However, one route will cross the Christina, providing an access point. That route is along Barksdale Road.

4. Riverfront Study for Wilmington, Delaware. (1977) A. C. Demetriou and Linton and Co.

This study recommends that a considerable portion of Wilmington's Christina shoreline be planned for marine recreation uses, greenways, and parkland. The proposed land use plan includes a greenway strip along the north bank of the Christina River to extend from the Delaware River westward to the South Market Street Bridge. A greenway strip is also proposed for the south bank of the River from the Amtrack Railroad Bridge at 495 to the Third Street Bridge, to serve as a buffer from industrial facilities and to improve the visual attractiveness from the north side of the River. Parkland was recommended for the tip of land at the confluence of the Christina River and Brandywine Creek, on the east side of Brandywine Creek, since that portion of land is not suitable for development. For the peninsula immediately north and west of the confluence, the plan proposes a mixed use development containing marinas, open space, recreational and incidental retail uses. This development would be designed so as not to infringe upon existing industrial development on the peninsula.

5. Christiana Preservation Plan. (1977) New Castle County Department of Planning.

This plan for the Christiana Historic area recommends a set of actions required to retain the historic character of Christiana and prevent further deterioration. Many of these recommendations are built around a current plan to divert substantial amounts of traffic from the existing Route 7 through the center of Christiana, onto the proposed Christiana Bypass. Additionally, it is recommended that historic zoning apply to all properties in the area. A state-owned property near the center of the area is targeted as a plaza-pocket park. Finally, a system of walkways and bike paths is advocated, the bike paths to

connect to the proposed Christina River Trail as proposed in the New Castle County Bikeway Plan.

6. Redevelopment Potential of the Delaware Urban Waterfront. (1979) William J. Cohen and Associates, Inc.

This study developed a framework for accomplishing redevelopment of the waterfront area of four Delaware Communities--Delaware City, New Castle, Newport, and Wilmington. Three of the sites recommended for priority consideration are situated along the Christina River. All three are in Wilmington. The former Wilson Shipbuilding site, on the north bank of the Christina River west of the confluence with the Brandywine Creek is recommended for purchase by the City of Wilmington for redevelopment to include: reuse of the main structure as a cultural facility, gift shop, and restaurant; reconstruction of the existing dock area to accommodate a historic vessel; and a waterfront park connected to Fort Christina Park. Another site at the confluence of the Christina and Brandywine, listed by this study as a priority site, is the 6.8 acre parcel owned by the City.<sup>10</sup> This site was judged to offer great recreation potential if developed in conjunction with the two existing marinas, to include a public launching area and a waterfront park and recreation area. The third site is also located on the north bank of the Christina River east of the Wilson site. This site, which includes 4.9 acres of vacant land is also recommended for acquisition by the City for the possible development of a historic village, a series of small shops, or a restaurant, in conjunction with the overall redevelopment effort for the entire peninsula.

7. A Pilot Plan For Wilmington's In-Town Riverfront. (1979) Wilmington Department of Planning.

This plan indicates that, "...there is no practical justification for

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<sup>10</sup> This is the same site referred to by the Report of the Governor's Task Force on Marine Recreation in Delaware; see page 22.



reserving the riverfront principally for industrial use, or for continuing the present City policy of excluding residential and commercial uses from the riverfront. Provision should be made for accomodating new uses, including recreational ones, along the waterfront. . ." <sup>11</sup> The plan also recommends retaining in their current state areas which are industrial in character. Accordingly, most of the Christina shoreline is planned for future industrial development. However, one area designated for commercial/recreational use is along the Christina on the peninsula from the confluence with the Brandywine west to Fort Christina Park. Marinas, marine and other recreation-oriented businesses are the uses suggested for this area.

8. Wilmington RUDAT. (1980) American Institute of Architects.

The City of Wilmington was the subject of a Regional/Urban Design Assistance Teams (RUDAT) effort, sponsored by the American Insitute of Architects, in 1980. Several of the recommendations concerned the Wilmington riverfront, specifically the Christina. The following recommendations directly affect the Christina Shoreline:

1. Christina River frontage for approximately one block east and west of Market Street should be developed as a waterfront park with promenade and other active and passive uses. A concrete plant immediately across the river could be acquired as part of the same open-space mode, giving lower Market Street a needed gateway image. A warehouse building just west of the proposed park could be developed for restaurant, shopping, or other uses.
2. The area at the southern gateway at Market Street should be left open space. This concept will tie in with the open vista pedestrian concept of the River to River plan.
3. The easterly end of the peninsula formed by the confluence of the two rivers should be re-zoned open space instead of commercial-industrial. This space, just north of the existing marina, would become a park for recreation purposes.

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<sup>11</sup> City of Wilmington Planning Department. A Pilot Plan for Wilmington's In-Town Riverfront. 1979; p. 5.

4. A 50-200 foot wide green belt easement should be designed and landscaped around as much of the entire peninsula on both the river banks as possible, extending upstream along both banks of the Brandywine Creek and Christina River.<sup>12</sup>

9. Project R.O.W. (Reclaim Our Waterfront). (1981) Cityside, Inc.

This study was undertaken by a non-profit community organization (Cityside, Inc.). The primary effort of the study was an analysis and inventory of all parcels of land in the shoreline areas of Wilmington's waterways to determine historical, environmental, and significant land use aspects of all these parcels. In view of these findings, recommendations are made on how to preserve or develop each land area in conjunction with overall waterfront improvement guidelines developed as part of the study. Among the waterfront guidelines are the following:

1. The City should make an effort to clean up trash and offer private property owners the incentive to do the same.
2. Developers should adaptively re-use historic structures and avoid irreversible changes to irreplaceable structures.
3. A system of historic markers which serve as a self-guided tour should be established.
4. Development proposals should encourage compatible mixed land uses that will encompass as many people-oriented activities as possible.
5. Establish boundaries for the city-owned waterfront street ends, then improve them for public use and access.
6. Use financial incentives and zoning restrictions to encourage labor-intensive service industries such as those related to tourism, recreation, retail shops, entertainment and leisure.
7. The City should make its waterfront properties and parks clean, attractive, and accessible.<sup>13</sup>

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<sup>12</sup> "The Rudat Times." Supplement to News Journal papers. May 1980; p. 6-8.

<sup>13</sup> O'Byrne and Thompson. "Project R.O.W.". Wilmington, DE: Cityside, Inc. 1981; Introductory Comments.

## LEGAL ASPECTS OF PUBLIC RIVER USE

Since the focus of this project is to determine recreational potential, the question of using the River for public use must be addressed. The following discussion is therefore presented as an overview of certain legal and statutory matters that ultimately will have relevance to recreation activities on the Christina.

### Who Owns the Christina?

To answer this basic question, Delaware Law provides two perspectives.

First, there is the perspective involving ownership of subaqueous lands.

Second, there is the perspective involving control of the water.

In reviewing applicable laws, a recent study found that the ownership of subaqueous lands is clearly established under jurisdiction of the State.<sup>14</sup>

In Delaware Code Chapter 64 the following is found:

Except as otherwise provided in this subchapter, the [Delaware Water and Air Resources] Commission and the Governor shall have exclusive jurisdiction, pursuant to this subchapter to convey a fee simple or less interest, to lease or grant permits or easements in or over any parts of the public lands of the State lying beneath the waters of the State (including the beach or shore to the mean high water level), and no use of such land shall be undertaken except pursuant to a permit or grant.

In addition to the above, the City of Wilmington has previously been granted by the State all rights to subaqueous lands within the municipal boundaries.

In 36 Delaware Laws, Chapter 147 the following grant of power appears:

An act of the General Assembly (36 Delaware Laws Chapter 147) makes the following provision:

Section 1. That the Governor of the State of Delaware be and hereby is authorized and directed to grant and convey to the

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<sup>14</sup> A Review of Institutional and Legal Aspects of Water Supply Policies in Delaware, Part Two (Dover, Delaware, Department of Natural Resources and Environmental Control, 1979) pp. 18-28.

Mayor and Council of the City of Wilmington, under the Great Seal of Delaware, all the right and title of the State of Delaware, in and to all the land under water within the limits of the said City of Wilmington where said land under water is located in or under any part of navigable streams.

The second perspective relative to control of the River (Water) is somewhat more vaguely addressed in Delaware Law. The historical legal distinctions that emphasized rights based on ownership of adjacent land (known as riparian rights), or vested rights to divert water from those lands (by prior appropriation) carry little, if any, weight.<sup>15</sup> The waters of the State are protected, regulated and allocated under the jurisdiction of the State of Delaware through the Department of Natural Resources and Environmental Control, as stipulated by 7 Delaware Code Chapters 60-61. The State has control of water allocation either through ownership of the water or as trustee of the resource. The rights of those using the water are use rights rather than property rights.<sup>16</sup>

In addition to these State law citations, it should be pointed out that the River and Harbors Acts of 1899 places navigable waterways under the regulatory auspices of the U. S. Army Corps of Engineers. This regulatory power would encompass all matters regarding boating, piers, bulkheading, and placement of navigational obstructions. However, Federal actions are now subject to a federal-state consistency review procedure as part of the Coastal Management Program. The Christina River has been classified by the Corps of Engineers to be navigable from its mouth in Wilmington to the Route 7 Bridge at Christiana—a total of 16 miles.<sup>17</sup>

#### State Legislation Directly Affecting Use of Waterways and Shorelines

While there are many State statutes and regulations that will affect the

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<sup>15</sup> Ibid., p. 27.

<sup>16</sup> Ibid., p. 28.

<sup>17</sup> U.S. Army Corps of Engineers, "List of Navigable and Non-navigable Waterways in the Philadelphia District." (1972), p. 2.

use of any waterways, the following excerpts provide the most relevant to the Christina:

a. 7 Delaware Code Chapter 59--Public Recreation on Private Lands.

This Chapter relieves private property owners of the duty to guarantee the safety of, and assume responsibility or liability for, any injury to any person using private lands for recreational purposes. The intent of the law was to encourage such use of private lands.

b. 29 Delaware Code Chapter 92--State Land Use Planning Act.

This law provides for intergovernmental review of land use and planning decisions made by any unit of government in the state when the consequences of such decisions would have "spillover" implications. That is, if a city or town excludes a land use which could have regional benefits, this decision would be reviewed at the State level. The State could then recommend that the decision be reversed (although a reversal cannot be mandated). Likewise, decisions made by the State are subject to review and comment by units of local government. Economic, social, and environmental impacts are the basis for this intergovernmental review.

c. [Proposed] 7 Delaware Code Chapter 74--Delaware River Heritage System Act.

This proposed legislation would establish a Rivers Heritage System to protect wild, pastoral, recreational, and cultural rivers and segments. The Act stipulates procedures for surveying, criteria for designation and government powers for implementation and conservation measures.

d. Wetlands Act. (1972)

This Act gives DNREC direct State control over lands between mean

low water elevation and 2 feet above local mean high water elevation upon which typical marsh plants grow. The following activities would require a permit from DNREC: dredging, draining, filling, excavation, and construction. A range of impacts must be considered in order for a permit to be conferred.

## WATER QUALITY

Water quality is one of the most important determinants of use potential for a waterway. Several recreational activities depend directly on acceptable water quality, although certain activities require better water quality than others. In general, low water quality will be suitable for boating only, although visual unattractiveness and odors may discourage boaters. With some improvement in water quality, the boating experience will be enhanced and limited fish species will thrive. Higher levels of water quality will permit primary contact recreation such as swimming and trout fishing.

"The value of water for any single recreational use will depend on a number of quality characteristics. . . .an increase in the magnitude of one quality characteristic may affect one use favorably while simultaneously affecting an alternative use negatively. Data limitation constraints and complexity suggest the need for using generality in applying water quality standards. Also, it is unclear which water quality variables are appropriate for recreation demand analysis."<sup>18</sup>

The State of Delaware Department of Natural Resources and Environmental Control (DNREC) has compiled water quality standards for streams and conducts a continuing testing program to monitor water quality throughout the State. The important findings with respect to the Christina River are summarized in this section. The complete data presentation and analysis is provided in Appendix 2, "Water Quality Technical Analysis." Recognizing the limitation on water quality data, as noted previously, the findings are expressed in qualitative rather than empirical terms.

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<sup>18</sup> R. K. Turner, "The Recreational Response to Changes in Water Quality: A Survey and Critique." International Journal of Environmental Studies. Vol. 11, 1977; pp. 91-98.

For purposes of studying water quality, the Christina River is divided into two segments in the Delaware 1980 Water Quality Inventory. The Upper Christina segment, above Smalley's Pond Dam is the non-tidal portion of the river. The Lower Christina, from Smalley's Pond Dam to the Delaware River is subject to tidal influence. The inventory report makes this summary assessment of the Lower Christina:

This lower portion of the Christina River can only be considered as fair. The water quality has improved since 1972, but the levels of fecal<sup>19</sup> coliform are still not meeting the State's water quality standards.

Concerning the Upper Christina, the summary assessment is as follows:

The water quality in the Upper Christina River may be considered fair to good. There is usually at least one parameter, usually the bacteria levels, which is in violation of State recommended levels. Based upon the two critical factors of dissolved oxygen and fecal coliform bacteria, the Upper Christina cannot be completely considered swimmable and fishable.<sup>20</sup>

Water quality sampling is conducted at 11 stations along the main stem of the Christina River. These stations are shown on Figure 11. Eight of the water components for which stream quality standards have been established are included in the monthly water quality sample data provided by the DNREC Technical Services Division. This data has been developed as follows:

First, monthly samples have been grouped into 4 seasonal averages.

Second, each station has been assigned a water quality assessment level of "acceptable", "conditionally acceptable", or "unacceptable" for each season. A station which is not in violation of any of the 8 standards is classified as "acceptable." Those in violation of 1-3 standards are classified as "conditionally acceptable." Those in violation of more than 3 standards are classified as "unacceptable."

The results of this analysis are shown in Table 12.

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<sup>19</sup> Delaware 1980 Water Quality Inventory, (Dover, DE: DNREC) 1980; p. 69.

<sup>20</sup> Ibid.; p. 71.



Table 12

## SEASONAL WATER QUALITY ASSESSMENTS AT ELEVEN SAMPLING STATIONS

## Christina River

Station	Winter (Jan.-March)	Spring (April-June)	Summer (July-Sept.)	Autumn (Oct.-Dec.)
Market Street	COND	COND	COND	COND
Route 4	ACC	COND	COND	COND
Smalley's Dam	ACC	ACC	COND	COND
Walther Road	ACC	ACC	COND	ACC
Salem Church Rd.	COND	COND	COND	COND
Route 72	COND	COND	COND	ACC
Old. Balt. Pike	ACC	COND	COND	ACC
Chestnut Hill Rd.	ACC	ACC	ACC	COND
Persimmon Run	COND	COND	COND	COND
Elkton Road	ACC	COND	COND	ACC
Nottingham Road	ACC	COND	COND	-

Legend: ACC = Acceptable; COND = Conditionally Acceptable; UNACC = Unacceptable

Source: DNREC Technical Services Division, 1980.

The relationship between water quality assessment levels and individual recreation uses will be discussed in subsequent sections of this study. In general, DNREC recommends the following activity uses for the Christina River:<sup>21</sup>

1. secondary contact recreation (e.g., boating)
2. primary contact in lakes and ponds only
3. fish, aquatic life, wildlife
4. navigation, in tidal portions only
5. anadromous fish

<sup>21</sup> Water Quality Standards for Streams. (Dover, DE: DNREC) 1970, p. 6.

Non-point source pollution is judged to be a significant problem for the entire river, since the shoreline includes many sources of urban stormwater runoff which are especially high in metal content. Point source pollution is generated by eight identified points of discharge, entering the river at seven locations. These locations are shown on Figure 11. Table 13 documents the nature and sources of point source pollution on the Christina.

Table 13  
IDENTIFIED POINT SOURCES OF POLLUTION  
Christina River

Source	Entry to Christina	Nature of Pollution
Halby Chemical Co.	directly into river at mile 0.6	withdrawal of 0.21 mgd from river for cooling and boiler make-up water; effluent is dis- charged into New Castle County Sewer System
Exxon Co.	directly into river at mile 3.5	contaminated storm- water runoff from oil storage containment dikes is discharged; no compliance schedule in effect
B & O Railroad	through Little Mill Creek tributary	stormwater runoff from fuel storage yard; no compliance schedule in effect.

Table 13 continued

Source	Entry to Christina	Nature of Pollution
DuPont Co.-- Chestnut Run	through Little Mill Creek tributary	non-contact cooling water, boiler blow- down steam condensate; no compliance schedule in effect
DuPont Co.-- Willow Bank	directly into river at mile 7.5	.15 mgd non-contact cooling water; no compliance schedule in effect
DuPont Co.-- Pigments Division	directly into river at mile 7.8	.36 mgd non-contact cooling water and boiler blowdown; no compliance schedule in effect
Wilmington Suburban Water Co.	through Smalley's Dam	6 mgd filtration plant; discharge occurs once every 3 months; abatement schedule has been implemented

Table 13 continued

Source	Entry to Christina	Nature of Pollution
DuPont Co.-- Stine Lab	through West Branch tributary	treated laboratory and sanitary waste- water; non-contact cooling water, boiler blowdown and stormwater; no compliance schedule in effect

Sources: Bruce Kraeuter, Review of Non-Domestic Point Source Discharges. New Castle County Areawide Waste Treatment Management Program, (1976).

Michael Stanton, New Castle County Stream Use Survey. Water Resources Agency for New Castle County, (1979).

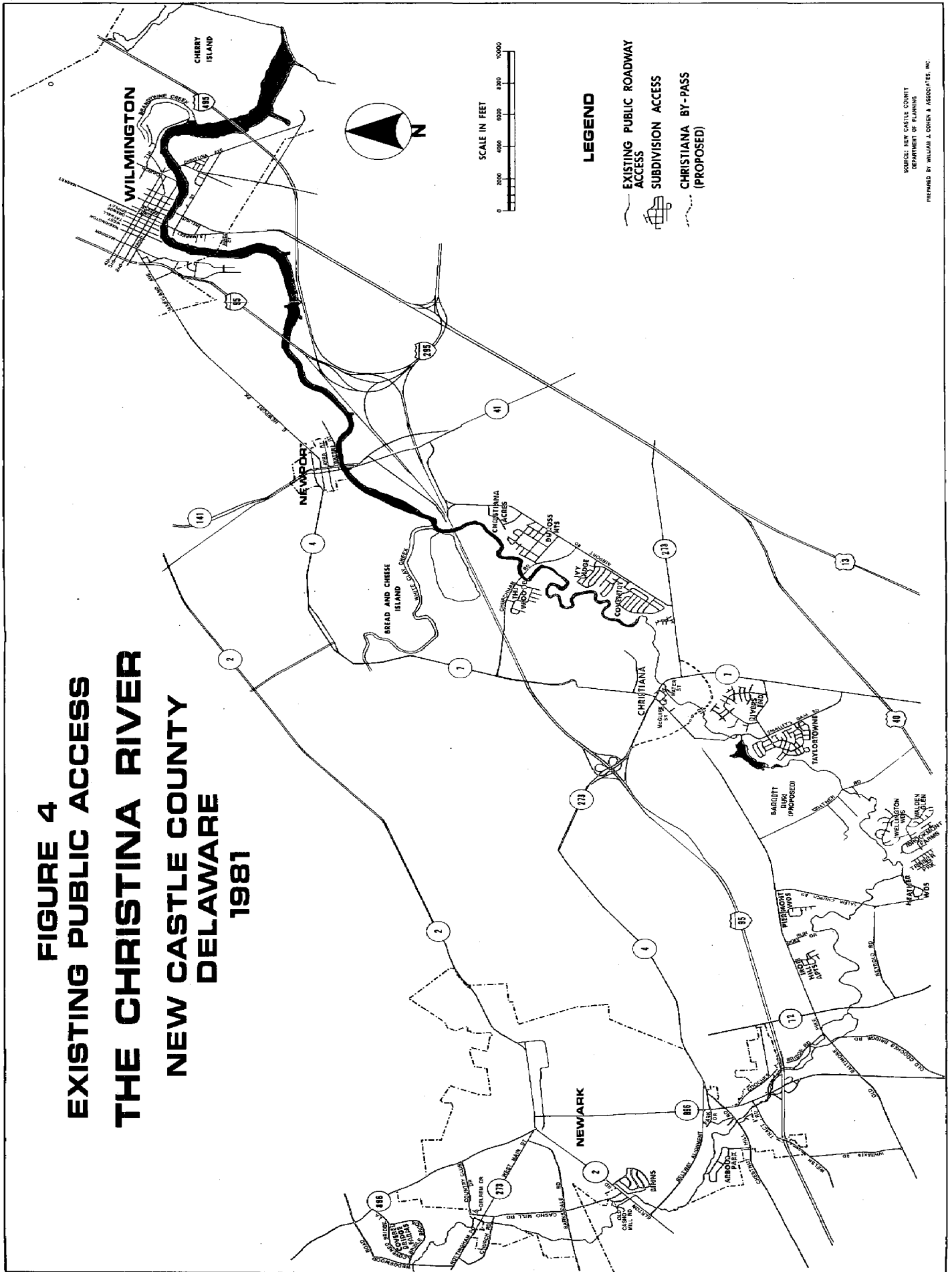
## PUBLIC ACCESS

There are currently 24 vehicular roadway crossings of the Christina River between the Maryland state line and the Delaware River, and 2 more are planned for future construction. However, direct public access has not been available at these crossings. The roadway crossings from Newport eastward are all well above grade and access from these roadways is not possible. Although the crossings west of Newport are all nearly at grade, currently there are no ramps or paths to provide direct access to the river shoreline and no safe place for motorists to pull off the road to gain access to the river. Pedestrian access for activities such as fishing is available at many locations, particularly where there is a network of urban streets contiguous to the river. The most prominent of these areas are in Wilmington (East 7th Street, Front Street); Newport (Water Street); Christiana (Water Street); and Newark (Old Cooch's Bridge Road). Public access is also available through existing public park and recreational areas (see Figure 3). In addition, several residential subdivisions contiguous to the Christina have dedicated open space areas for potential future use. (See Table 8).

Boating access is also very limited. The only currently used public boat launching site on the Christina is the East 7th Street Park in Wilmington, at the confluence of the Christina River and Brandywine Creek.

In conclusion, direct public access to the Christina is currently very limited, except through public parks and pedestrian access. Figure 4 displays existing and potential access points of access to the Christina River.

**FIGURE 4**  
**EXISTING PUBLIC ACCESS**  
**THE CHRISTINA RIVER**  
**NEW CASTLE COUNTY**  
**DELAWARE**  
**1981**



## POTENTIAL RECREATION AREAS

### Determining Recreation Uses

This section of the study will provide the analytical framework by which to identify recreational potential of the Christina. The approach has been to combine several methods of analysis that are practical and will lead to meaningful results.

To begin, potential recreational uses are divided into two classes: Land Based and River Based. This has been done in order to distinguish between various activities that require different criteria in order to be pursued. The division of recreational activities into these two classes includes the following:

#### Land Based Recreation

- hiking
- nature observation
- picnicking
- bicycling
- athletics
- camping

#### River Based Recreation

- canoeing
- sailing
- swimming
- fishing
- small craft boating

### Determining Methods of Analysis

In order to establish the relationship between land and river based recreational activity on the one hand, and certain physical characteristics and other variables on the other, a review has been conducted to establish a methodology



that could be easily used by the researcher and understood by the reader. To achieve this objective, four general methodological approaches have been evaluated and used in various ways as the subsequent presentation will indicate.

1. The Recreational Survey Model, prepared for the Delaware Nature Education Society.
2. The Automated Environmental Resource Information System (AERI) for New Castle County.
3. Research involving existing reports, studies, plans, sampling data, and related data.
4. An empirical review of existing physical and man-made features through field observations and cartographic analysis.

The first two of these methods deserve a more in depth exploration as provided below.

The Recreational Survey Model (draft) prepared for the Delaware Nature Education Society basically is intended to be ". . .capable for measuring the recreational potential of all rivers within the State of Delaware."<sup>22</sup> Moreover, the model determines the nature of the relationships between physical features, variables, and potential recreation uses.

The model is a sophisticated arrangement that includes 27 recreation uses that are evaluated against a combination of 100 variables. Since the Christina River is not expected to provide certain types of recreational activities as identified by the model (e.g., rafting or ice fishing) for purposes of this study, both land based and river based recreational activities have been generalized and could subsume several of the recreational activity categories listed in the model. In effect, then, the Recreational Survey Model has been utilized

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<sup>22</sup>Elena Babig, Recreational Survey Model (draft), prepared for the Delaware Nature Education Society (Delaware Technical and Community College) 1980.

as a guide, and adjustments have been made that will render realistic results for the Christina River analysis.

The Automated Environmental Resource Information System (AERI) was created under the New Castle County Areawide Waste Treatment Management (208) Program and provides an array of data in a format that is taken by the user for analysis. The nature of a relationship (for example between a defined land use and a recreational activity) is first outlined in order to obtain the special distribution of physical-geographical data.

#### Land Based Recreational Use Suitability

In order to have an understanding of certain land use characteristics that will impact the recreational potential of land based activities, the Automated Environmental Resource Information System (AERI) has been utilized. This system, managed by the Water Resources Agency of New Castle County is a "coordinated, integrated environmental data system prepared in geo-based format which offers computer storage of data. . ."<sup>23</sup> The value of the AERI system is that it is a tool to provide a mapping of information that can serve as a basis for suitability analysis. Therefore, the prime focus of incorporating the AERI system will be to identify the suitability for recreation activities based on physical-environmental factors defined for the Christina River Corridor. The AERI system contains variables of data (such as soils, and land use information) that are stored on a data base known as a "cell." Each cell equals a 500 x 500 foot section of New Castle County or approximately 5 acres of land area. Therefore, any number of cells can be combined or aggregated to determine the physical-environmental-resource constraints for any site or area within the county.

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<sup>23</sup> New Castle County Areawide Waste Treatment Management (208) Program, Capability Mapping as a Means of Improving Environmental Quality: Prerequisites and Methods (1977), p. 1.

As a general remark it should be noted that the subsequent presentation relative to land suitability is mapped, showing a relationship to a particular recreational use. That is to say, certain, "common sense" considerations had to be made as to which combinations of data from the AERI system would be most applicable to determine recreational use suitability. For example, each land based recreational use (e.g., hiking, athletics, etc.) was related to selected data variables, and based upon that relationship the land area within the defined river corridor was judged (by the computer) to be either "suitable" or "conditionally suitable" for a particular recreational use. This judgment was made after a review of relevant variables that could be combined to provide a practical assessment. A summary description of the variables included the following:

- \*land cover--which represents "land use" including the type such as forests, agricultural land, developed land (e.g., residential, commercial land use), existing recreation land, etc.

- \*soils limitations--based on physical and engineering characteristics including drainage, texture of surface, degree of erosion, flood hazard, etc.

The first step in retrieving information from the AERI system involved the definition of a River corridor. Second, the physical-environmental factors that make up each of the land based recreational activities were identified. Third, a computer program was developed to obtain data from AERI,<sup>24</sup> and from the data a printout was made in the form of a map. Thus the maps, shown as Figures 5 through 10 geographically portray the suitability of land for each recreational

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<sup>24</sup>Technically this is referred to as "The Christina River Corridor Data List" (1981).

use along the river.

#### 1. Hiking Suitability

The suitability for hiking is based on a combination of land cover and soil data. The essential question explored then is, "what existing land uses and soil properties are either suitable or conditionally suitable to encourage hiking." Table 14 shows a generalized breakdown of the two data variables (land cover and soils) that were ultimately resolved from the AERI data. Figure 5 shows hiking suitability graphically portrayed.

Table 14

#### HIKING SUITABILITY VARIABLES

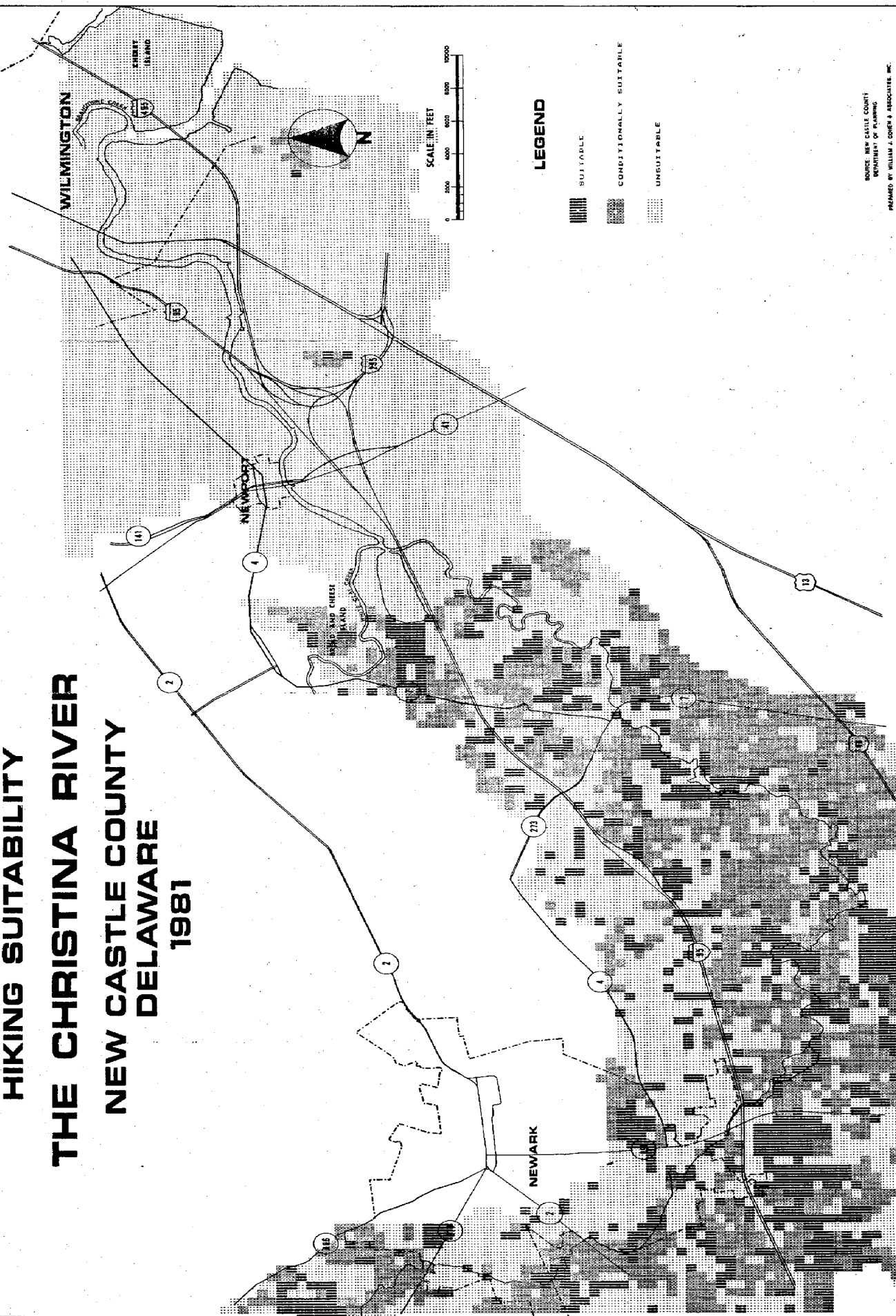
##### Christina River Corridor

	Land Cover Variables	Soils Variables
Suitable	forests all developed parkland	slight limitations (according to Soil Conservation Service analysis for "Lawns and Golf Fairways")  A severe or moderate slope is considered suitable for hiking for each soil classification.
Conditionally Suitable	agricultural land brush land wetland vacant land	moderate limitations for "Lawns and Golf Fairways"

Sources: Areawide Waste Treatment Management (208) Program, 1980.

U.S. Department of Agriculture, Soil Conservation Service, Soil Survey New Castle County (1970), Table 7.

# **FIGURE 5** **HIKING SUITABILITY** **THE CHRISTINA RIVER** **NEW CASTLE COUNTY** **DELAWARE** **1981**



## 2. Nature Observation Suitability

This use is based on an evaluation of soil conditions as they relate to the productivity of plants to support wildlife. For example, a very productive soil with a forest land cover will provide an ideal habitat for woodland animals (e.g., deer). Figure 6 shows the areas determined most suitable and suitable for nature observation based upon the suitability variables in Table 15.

Table 15

### NATURE OBSERVATION SUITABILITY VARIABLES

#### Christina River Corridor

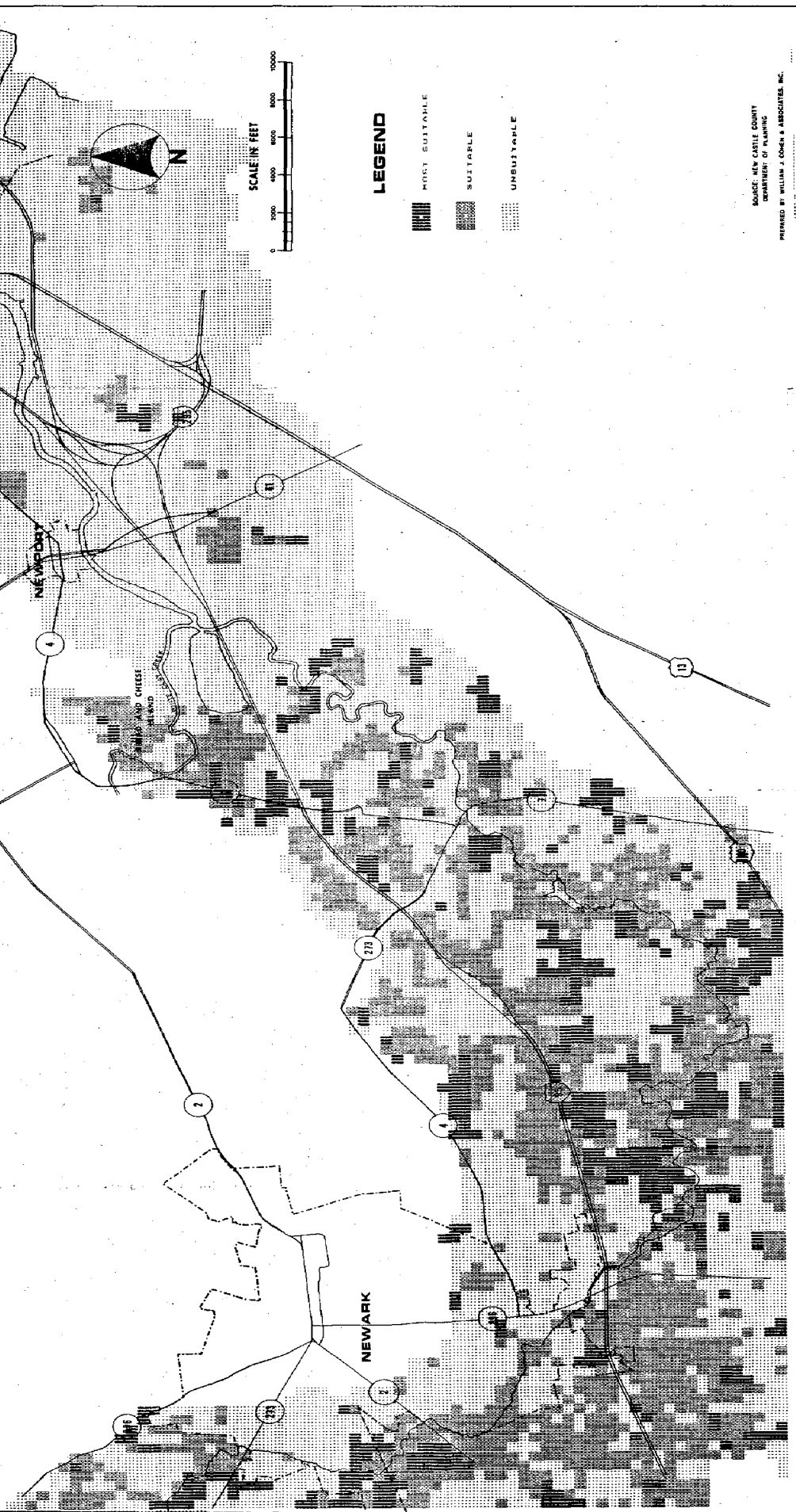
	Soils and Land Cover Variables
Most Suitable	most productive combination of soils and land cover to support <u>all</u> of the following: open land wildlife woodland wildlife wetland wildlife unique natural areas
Suitable	most productive combination of soils to produce land cover to support <u>any one</u> of the following: open land wildlife woodland wildlife wetland wildlife unique natural areas

Sources: Areawide Waste Treatment Management (208) Program, 1980

U.S. Department of Agriculture, Soil Conservation Service, Soil Survey  
New Castle County (1970), Table 7.

Delaware Nature Education Society, New Castle County Natural Areas  
Study (1975).

**FIGURE 6**  
**NATURE OBSERVATION SUITABILITY**  
**THE CHRISTINA RIVER**  
**NEW CASTLE COUNTY**  
**DELAWARE**  
**1981**



### 3. Picnicking Suitability

This use incorporates the same variables used to evaluate hiking, that is, land cover and soils (as discussed above) with the slope of land being considered as a positive or negative factor. Table 16, Figure 7 provides the appropriate information.

Table 16  
PICNICKING SUITABILITY VARIABLES  
Christina River Corridor

	Land Cover Variables	Soils Variables
Suitable	forests all developed parkland	slight limitations (according to Soil Conservation Service analysis for "Lawns and Golf Fairways"). A slight slope 5-10% is considered suitable for picnicking for each classification.
Conditionally Suitable	agricultural land brush land wetland vacant land	moderate limitations for "Lawns and Golf Fairways." A moderate slope 8-15% is considered conditionally suitable.

Sources: Areawide Waste Treatment Management (208) Program, 1980.

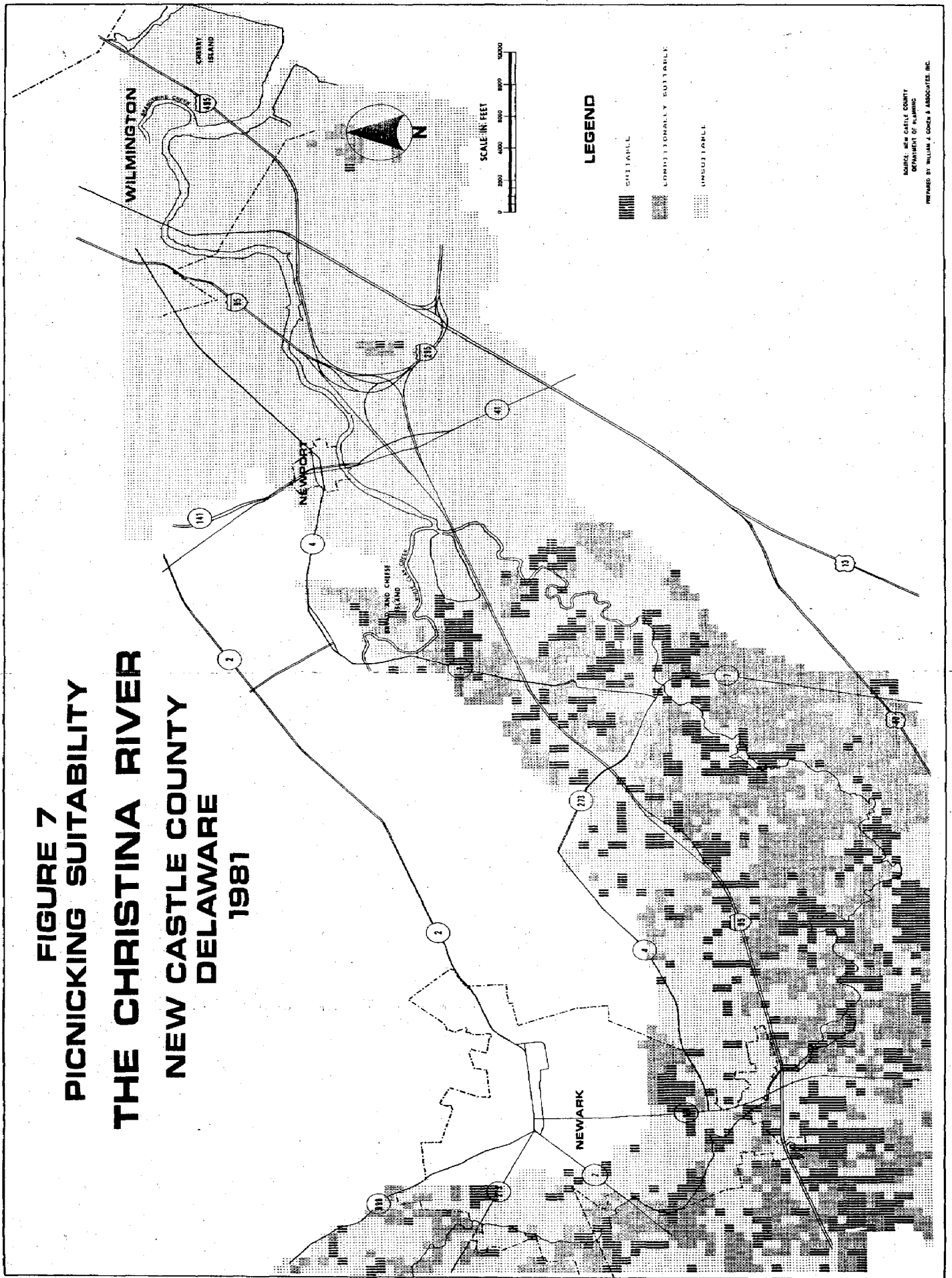
U.S. Department of Agriculture, Soil Conservation Service, Soil Survey  
New Castle County (1970). Table 7.

### 4. Bicycling Suitability

Suitability for bicycling has been developed with a minor adjustment of the soil variable used to determine hiking (i.e., suitability for lawns and golf fairways). In addition, a variety of urban land uses are considered desirable for bicycling—such as residential and intensive recreation areas which would



**FIGURE 7**  
**PICNICKING SUITABILITY**  
**THE CHRISTINA RIVER**  
**NEW CASTLE COUNTY**  
**DELAWARE**  
**1981**



provide existing paved areas and low traffic volumes that are suitable for bicycling. Another category consisting of non-urban land cover such as forests have also been incorporated in the analysis because with some improvement they add to the recreational experience. Table 17 provides a summary listing of the key suitability variables while Figure 8 graphically illustrates the suitable and conditionally suitable areas along the river corridor for bicycling.

Table 17

BICYCLING SUITABILITY VARIABLES

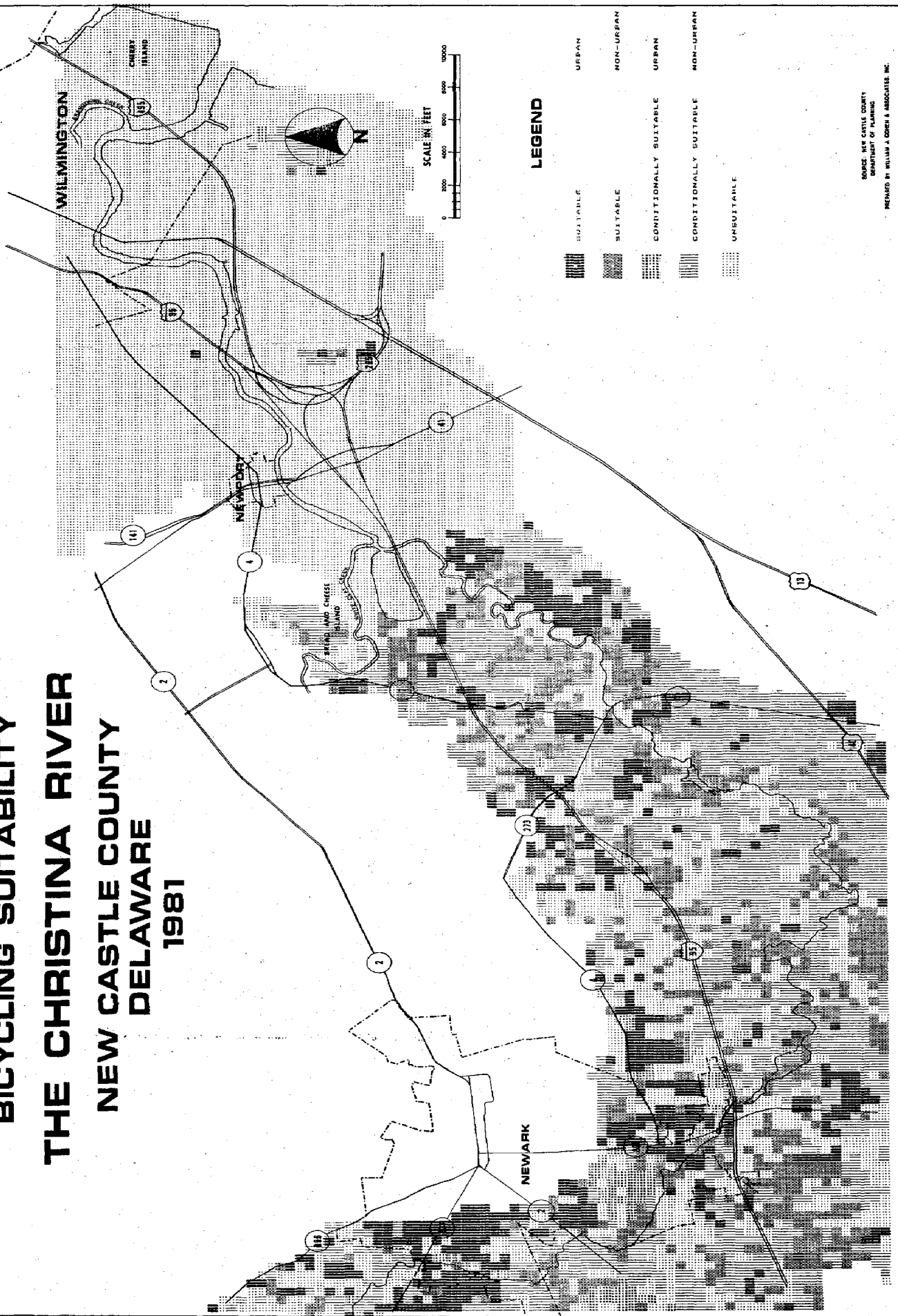
Christina River Corridor

	Land Cover Variables	Soils and Land Cover Variables
Suitable-Urban Suitable Non-Urban	single family residential institutional rights-of-ways (communications) intensive, general, open, and other recreation forests	slight limitations for "Lawns and Golf Fairways." Since slope is a limitation for bicycling, a modification to the soil data has retained slope as a constraint
Conditionally Suitable-Urban Conditionally Suitable Non-Urban	commercial services wholesale industrial agriculture brush land wetland vacant land	moderate limitations for "Lawns and Golf Fairways." Same slope constraint as for picnicking.

Sources: Areawide Waste Treatment Management (208) Program, 1980.

U. S. Department of Agriculture, Soil Conservation Service, Soil Survey New Castle County (1970), Table 7.

# **FIGURE 8** **BICYCLING SUITABILITY** **THE CHRISTINA RIVER** **NEW CASTLE COUNTY** **DELAWARE** **1981**



SOURCE: NEW CASTLE COUNTY  
 DEPARTMENT OF PLANNING  
 PREPARED BY: WILLIAM J. COOPER & ASSOCIATES, INC.

## 5. Athletics Suitability

The activity of athletics includes all traditionally active recreational sports, especially those that require a playing field or court that must be constructed and maintained to facilitate use. Athletic suitability is defined as having suitable soils near urban areas. Figure 9 shows suitable and conditionally suitable soils near the urban area for athletics. Table 18 provides the soil suitability factors.

Table 18

### ATHLETICS SUITABILITY VARIABLES

#### Christina River Corridor

##### Soils Variables

Suitable	slight limitations for athletic fields and other intensive play areas
Conditionally Suitable	moderate limitations for athletic fields and other intensive play areas relative to slow permeability, high water table, and 5-10% slope

Sources: Areawide Waste Treatment Management (208) Program, 1980.

U. S. Department of Agriculture, Soil Conservation Service, Soil Survey New Castle County (1970), Table 7.

## 6. Camping Suitability

For this recreational activity, the interpretation has been made for camping with trailers, rather than backpacking or camping with tents. To determine suitability of land for camping the analysis is based on soil and land cover. Table 19 and Figure 10 provide the appropriate variables and graphic findings.

## FIGURE 9 ATHLETICS SUITABILITY

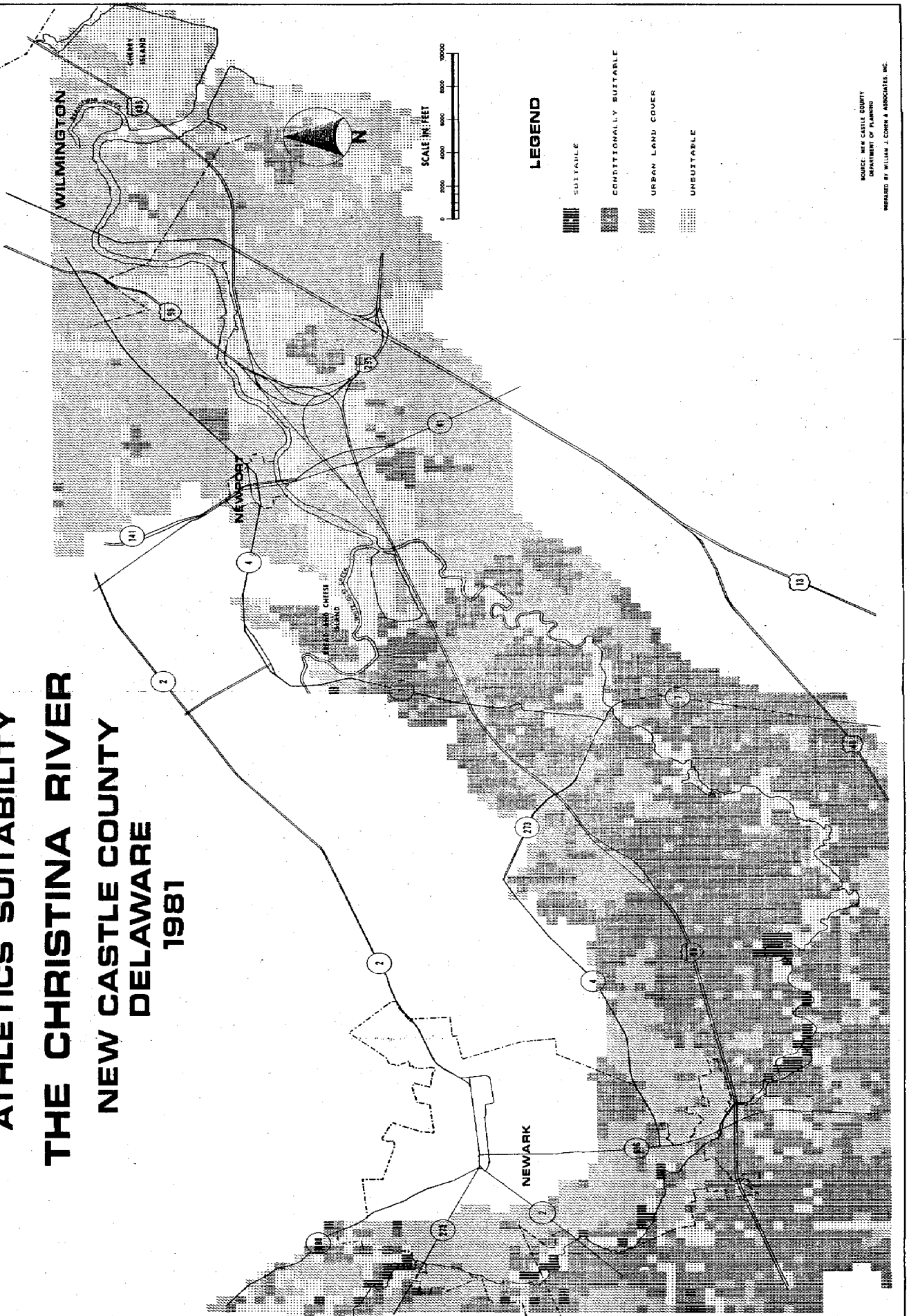


Table 19

## CAMPING SUITABILITY VARIABLES

## Christina River Corridor

	Land Cover	Soils
Suitable	forests all developed parkland	slight limitations for campsites (intensive use)
Conditionally Suitable	agricultural land brush land wetland vacant land	moderate limitations for campsites (intensive use)

Sources: Areawide Waste Treatment Management (208) Program, 1980.

U. S. Department of Agriculture, Soil Conservation Service, Soil Survey,  
New Castle County (1970), Table 7.

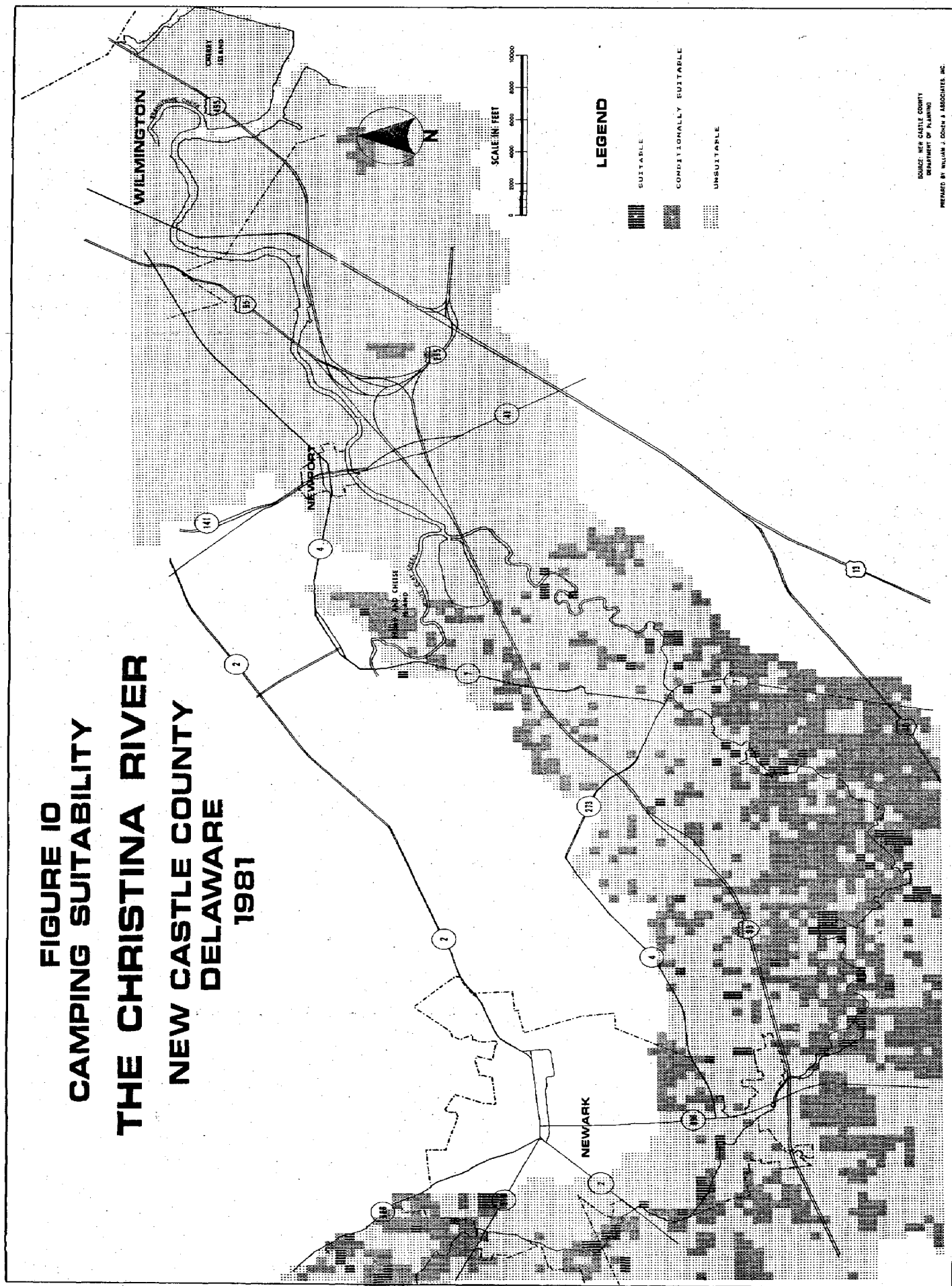
#### River Based Recreational Use Suitability

An analysis of the river based recreational potential of the Christina River requires a somewhat different emphasis than was employed in reviewing land based activities. The river based suitability is dependent on various relationships among several variables that specifically relate to water quality and physical characteristics (such as tidal influence and navigational obstructions). This section of the study will review the appropriate variables for each identified recreational use.

##### 1. Swimming

Swimming requires the highest level of water quality of any river based recreation activity. Table 12 shows that during the summer months, all but one

# **FIGURE 10** **CAMPING SUITABILITY** **THE CHRISTINA RIVER** **NEW CASTLE COUNTY** **DELAWARE** **1981**



SOURCE: NEW CASTLE COUNTY  
 DEPARTMENT OF PLANNING  
 PREPARED BY WILLIAM J. COHEN & ASSOCIATES, INC.

of the water quality sampling stations contain violations of at least one water quality standard (i.e., conditionally acceptable). The levels of fecal coliform bacteria, an important determinant of water suitability for primary contact recreation, are dramatically high at most sampling stations during the summer and spring months, more fully explained in Appendix 2. For these reasons, it has been determined that the main stem of the Christina River is not suitable for swimming, given the continuation of current water quality conditions.

In the State Water Quality Standards for Streams, it is recommended that primary contact recreation on the Christina take place in lakes and ponds only. In this regard, it should be noted that Beck's Pond located on Belltown Run is currently a popular location for swimming, as well as fishing, picnicking, and boating.

## 2. Fishing

Research has been undertaken concerning fishing potential which indicates that virtually the entire Christina River contains a variety of fish species to attract the angler. Water quality necessary to support fish populations depends primarily on adequate levels of dissolved oxygen. As documented in Appendix 2, the dissolved oxygen levels found in water quality samples in the Christina are well in excess of recommended minima in autumn, winter, and spring. The summer samples indicate slight violations at 3 stations (Third Street, Smalley's Dam, and Route 72), while 2 other stations fall below the stricter standards recommended for fish (Walther Road and Old Baltimore Pike). Despite these violations, extensive fish catchings have been recorded during the summer months. It should be remembered, however, that water quality degradation of other types (low alkalinity, high coliform bacteria, high ammonia nitrogen) may impair the quality of the fish in the river even if they do not reduce fish populations.



With regard to fishing in the tidal portion of the river (up to 11 miles from the mouth), Figure 11 shows sampling stations where fish catches have been recorded. Table 20 shows the results of these two studies.

## 1981



Table 20

## FISH SAMPLES IN CHRISTINA RIVER

Miles From Mouth	Date of Sample	Fish Caught*
Mouth	April-June 1976	American Shad. Alewife Blueback Herring Brown Bullhead White Perch White Catfish Atlantic Menhaden Carp Redbreast Sunfish Goldfish Pumpkinseed Gizzard Shad White Sucker Walleye
2.3	July-August 1975	Blueback Herring Silvery Minnow White Perch Bay Anchovy
2.7	September-October 1975	Gizzard Shad Menhaden Bay Anchovy
3.8	April-June 1978	Black Crappie Carp Goldfish Menhaden Silvery Minnow White Perch White Sucker
4.4	April 1978	Carp
5.2	July 1978	Blueback Herring Carp Menhaden Silvery Minnow

Table 20 continued

Miles from Mouth	Date of Sample	Fish Caught*
7.8	August 1978	Blueback Herring Menhaden Silvery Minnow
10.2	September 1978	Blueback Herring
10.8	April-June 1975	Alewife Blueback Herring White Catfish
	September-October 1975	Blueback Herring Gizzard Shad
	May 1978	Blueback Herring

\*10 or more of species during period of sample collection

Sources: Scott J. Beck, and Victor J. Schuler, Ichthyological Associates, Inc. 1976.

Richard C. Reichard, Delaware River Basin Anadromous Fishery Project. Completion Report. (1979).

Fishing in the non-tidal portion of the Christina is also appealing. The Christina is a designated trout water from the Maryland State line to Rittenhouse Park. It is stocked at least once a year at the state line. During the 1979 season, the Christina was stocked with a total of 3,520 trout.<sup>25</sup> Sixteen species of freshwater fish are known to make their habitat in the Christina; the smaller fish most commonly. The following species are included:<sup>26</sup>

<sup>25</sup> Michael Stanton, New Castle County Stream Use Survey. Water Resources Agency for New Castle County, (1979).

<sup>26</sup> Ibid.

Redbreast Sunfish  
 Bluegill  
 Largemouth Bass  
 Fallfish  
 Common White Sucker  
 Common Shiner  
 Tessellated Johnny Darter  
 Spottfish Shiner  
 Common Sunfish  
 Black Crappie  
 Chain Pickerel  
 Yellow Perch  
 Golden Shiner  
 Eastern Blacknose Dace  
 Great Lakes Longnose Dace  
 Tadpole Madton

Beck's Pond (located near the junction of Belltown Run and the Christina River) is a highly attractive fishing area, with the most fish caught per hectacre among all state-owned ponds in 1976. Largemouth bass, back crappie, sunfish, chain pickerel, perch, catfish, and carp are most prevalent.<sup>27</sup>

Fishing along the banks can take place at almost any location on the river. In fact, fishermen can now be observed along the Christina throughout the year. Rittenhouse Park and Hidden Valley in Newark as well as several sites in Wilmington are especially popular. The new state law, Public Recreation on Private Lands (see page 34) should insure that access for recreation fishing exists.

### 3. Canoeing Suitability

Canoeing on the Christina can include pleasure, casual activities, as well as flat water racing or marathon canoeing. To determine the suitability of the river for this recreational use the following variables have been considered:

\*tidal influence

\*water depth

Both of these factors are mapped as shown on Figure 12 and indicate a fairly long reach on the Christina that would be suitable for canoeing. The tidal

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<sup>27</sup> Roy W. Miller, A Survey of Freshwater Fishing in Delaware. (Dover, DE: Delaware Division of Fish and Wildlife) 1978; p. 16.

influences--from Smalley's Dam--would be more severe at the mouth and accordingly should be taken into account in light of the type of canoeing desired.

The suitability of the River for canoeing can be summarized to include the 15 miles from Smalley's Dam to the mouth in Wilmington. Aesthetics will also play a major role in whether people will use the river for pleasure canoeing. In this respect, the reach between Churchman Road, south of Newport, to Smalley's Dam offers the most attractive vistas for canoeing.

#### 4. Sailing Suitability

This river based activity is heavily dependent on the following variables:

- \*tidal influence
- \*navigational obstructions
- \*water depth

Table 21 provides a key to the significant navigational obstructions that would be encountered; these are physically oriented on Figure 12.

Table 21  
 NAVIGATIONAL OBSTRUCTIONS  
 Lower Christina River

Location	Nature of Obstruction
A	Railroad Swing Bridge; vertical clearance 6 feet
B	Sunken barge visible at low tide but submerged at high tide
C	Third Street Draw Bridge (new); vertical clearance 18 feet. The old 3rd Street Bridge will be removed.
D	Walnut Street Draw Bridge; vertical clearance 19 feet
E	Market Street Draw Bridge; vertical clearance 8 feet
F	Railroad Swing Bridge; vertical clearance 6 feet
G	Railroad Swing Bridge; vertical clearance 3 feet
H	Railroad Swing Bridge; vertical clearance 2 feet (according to U. S. Army Corps of Engineers this bridge is open and abandoned)
I	I-95 fixed bridge; vertical clearance 22 feet

Note: Unless otherwise stated, all draw and swing bridges will open on signal or in accordance with established regulations.

Source: National Oceanic and Atmospheric Administration, Nautical Chart, Delaware River (Smyrna River to Wilmington) 1978.

Since sailing is limited by the height limitations of river crossings (including roadways and railroad bridges), there are three identified segments on the lower river that are suitable.

\*Segment 1. Between East 7th Street in Wilmington (at the confluence of the Christina with the Brandywine to the mouth, and on into the Delaware River.

\*Segment 2. Between Walnut Street in Wilmington (D on Figure 12) and the railroad swing bridge shown as A on Figure 12.

\*Segment 3. Between Market Street in Wilmington (E on Figure 12) and Newport.

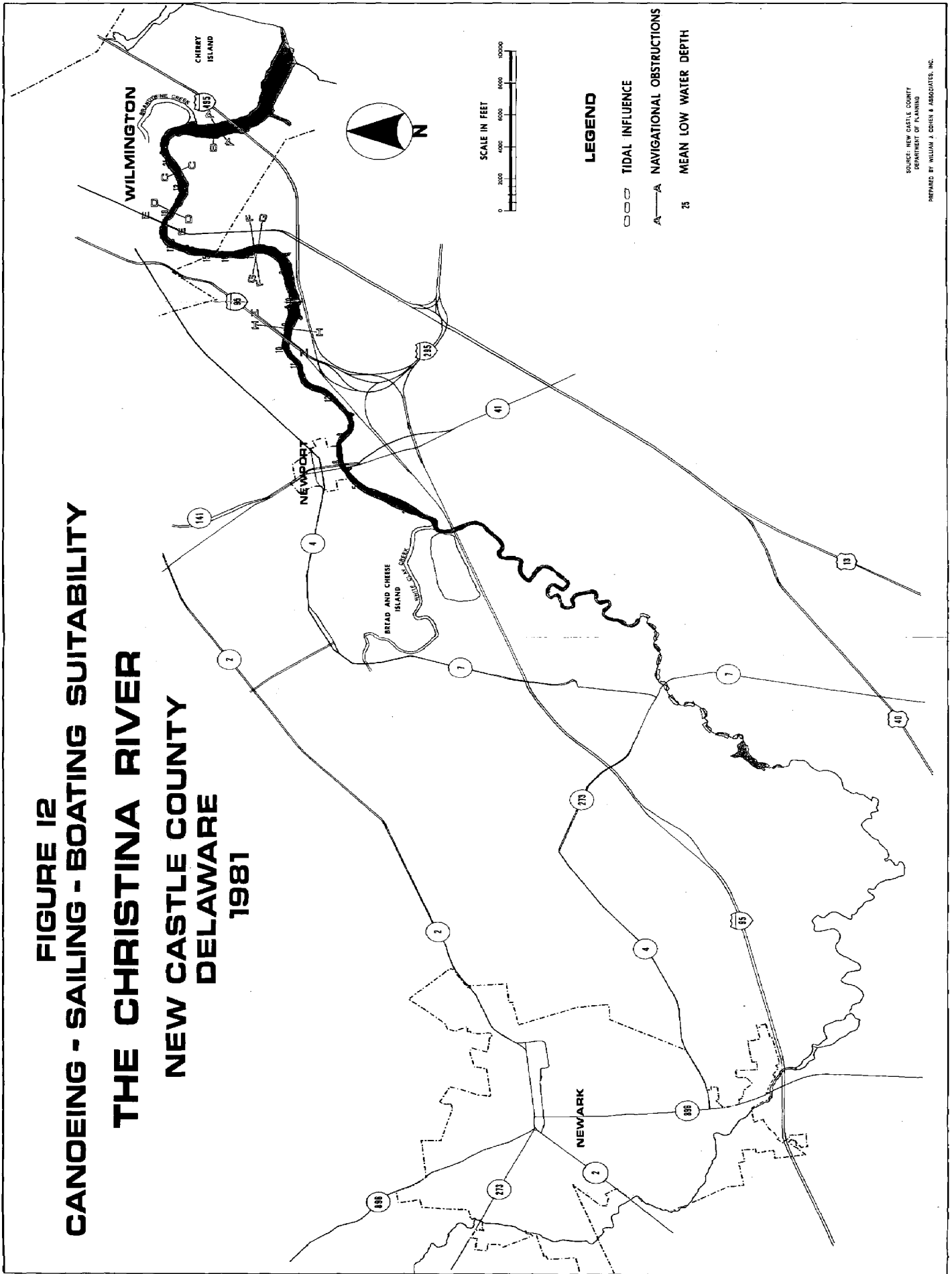
The kind of sailing vessel that can be accommodated in each segment will be contingent upon boat length, depth of keel, and height of mast.

#### 5. Small Craft Boating

This category of river based recreational uses includes small power boats, runabouts, power dingys, and larger deep craft pleasure vessels. The key suitability variable is water depth and to a lesser extent tidal influence. Figure 12 provides the depths of the river that can be used as a guide to determine the size of the boating craft that could use the river. It could be assumed that at high tide a small boat under power could go as far up the river as Rt. 7 at Christiana.



# **FIGURE 12** **CANOEING - SAILING - BOATING SUITABILITY** **THE CHRISTINA RIVER** **NEW CASTLE COUNTY** **DELAWARE** **1981**



## POTENTIAL RECREATIONAL SITES AND USES

### Composite Recreational Potential

The preceding analysis of land based and river based recreational uses can be viewed as to their potential along definable segments of the river. Therefore, the following activity areas (or segments) are believed to be a relevant subdivision of the Christina River main stem for purposes of allocating various levels of potential recreational use.

Activity Area 1. Mouth of the Christina at Wilmington (the confluence with the Delaware River) to Newport--a total of 7.75 miles

Activity Area 2. Newport to Smalley's Pond Dam--a total of 7.25 miles

Activity Area 3. Smalley's Dam to I-95--a total of 8.81 miles

Activity Area 4. I-95 to the Delaware-Maryland State line--a total of 6.49 miles

A further focus on each activity area in relation to recreational potential is shown in Table 22 which indicates highest potential, potential, or no potential for each land based and river based recreational use. As a point of qualification, it should be clear that this conclusion is based on all subsequent information and analysis. It therefore, could be possible, in isolated situations, to find a "suitable site" for some recreational use within an activity area designated as having "no potential."

Table 22

## RECREATIONAL USE POTENTIAL BY ACTIVITY AREA

Christina River

Activity Area	Land Based							River Based			
	Hiking	Nature Observation	Picnicking	Biking	Athletics	Camping	Canoeing	Sailing	Small Craft Boating	Swimming	Fishing
Mouth to Newport	O	O	O	O	O	O	HP	HP	HP	O	HP
Newport to Smalley's Dam	HP	HP	HP	HP	O	P	HP	O	P	O	P
Smalley's Dam to I-95	HP	HP	HP	HP	P	HP	O	O	O	O	P
I-95 to Stateline	P	P	P	HP	HP	P	O	O	O	O	HP

HP highest potential

P potential

O no potential

Source: William J. Cohen and Associates, Inc.

A final level of analysis involves combining the recreational use potential with points of public access and the location of public lands. Figure 13, Composite Recreational Potential, is the synthesis of this evaluation. In addition, the "highest priority sites" as shown on Figure 13 is developed from an overlap of 3 or more suitable land based recreational uses.

Although most of the potential land for recreational use is in private ownership, there are, nevertheless, significant areas of publicly owned land that can be utilized for both land based activities as well as river based activities, primarily as launching sites for canoeing, sailing, and small craft boating.

A more detailed explanation of the potential recreation areas outlined on Figure 13 will specify recreational uses that could be implemented.

#### Potential Recreational Sites

Following from the composite recreational potential analysis, four new sites can be identified along the Christina River that meet certain criteria as follows:

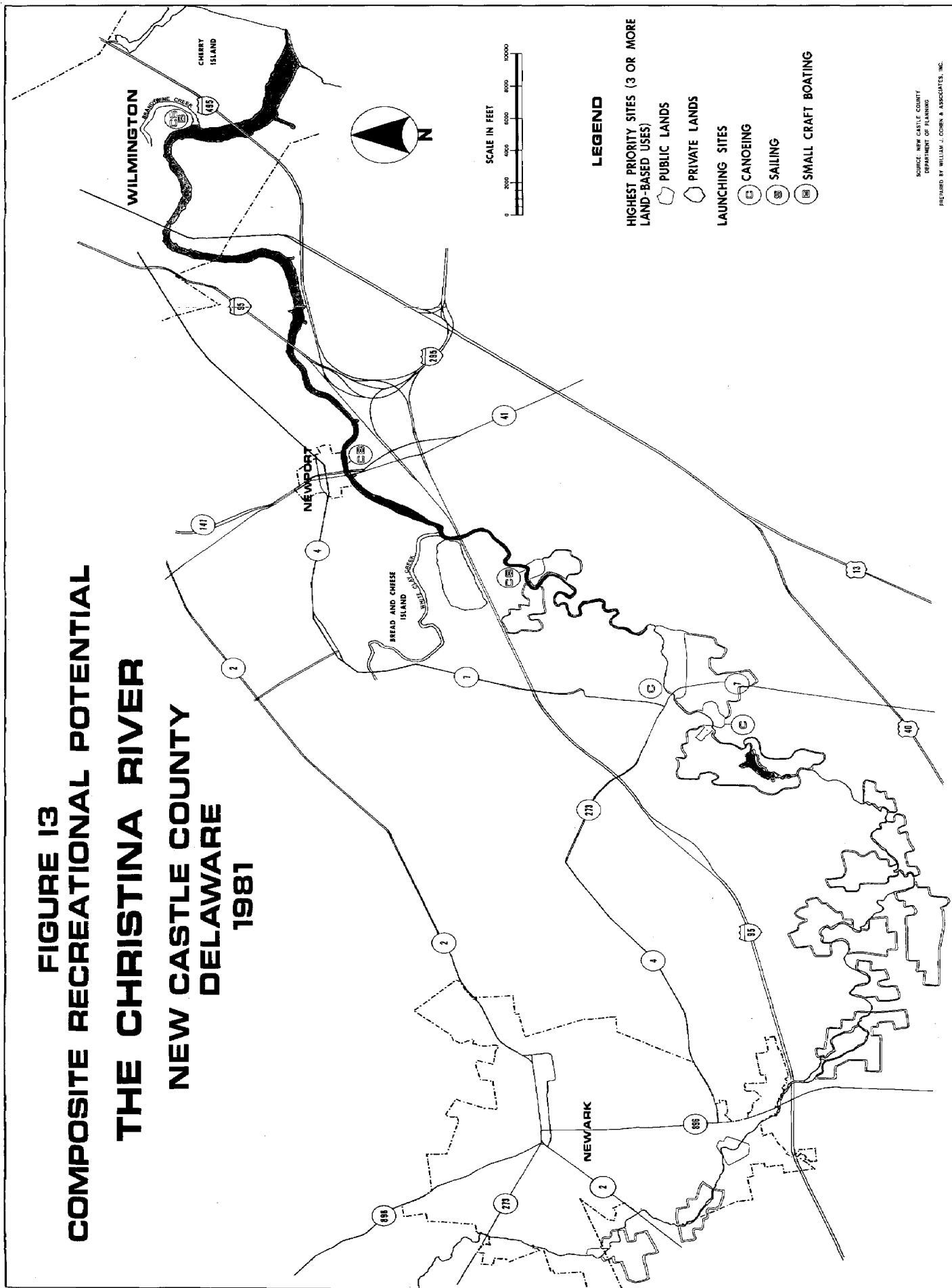
- \*fronting on the river
- \*publicly owned
- \*be suitable for at least three land based or two river based recreational activities
- \*have public access or potential access

#### 1. Newport Site

Within the corporate limits of Newport a .5-acre site is owned by the state, fronting on the north side of the River with public access from Water Street and east of the Rt. 41 overpass. Even though small in size, this site could serve as a launching area for canoeing and small boats.

On the south side of the Christina there is a large stretch of state owned land along the river and east of Rt. 41, with public access from Old Rt. 141.

# **FIGURE 13** **COMPOSITE RECREATIONAL POTENTIAL** **THE CHRISTINA RIVER** **NEW CASTLE COUNTY** **DELAWARE** **1981**



Previous analysis has not indicated this area to be suitable for land based activities, however, a launching site at this location for canoes and small boats would be viable.

## 2. Churchman(s) Road Site

The State owns a 1.1 acre parcel of land on the south-east corner of the Churchman Road crossing of the Christina. Access is direct from the road shoulder. The land based analysis indicated that this area would be suitable for hiking, nature observation, picnicking, and camping. In addition, this location could serve as a launching area for canoeing and small craft boating.

## 3. Christiana By-Pass Sites

The State of Delaware will complete Right-Of-Way acquisition in 1981 for the proposed Christiana By-Pass with construction to be completed by 1984. The By-Pass will connect Rt. 273 (Hares Corner Road) with the I-95 interchange (at Rt. 273) and cross the Christina just south of Old Baltimore Pike as shown on Figure 4. Certain lands on both sides of the river have been or will be acquired for this roadway improvement with some lands declared as "excess"-- not required for construction or right-of-way purposes. Two areas owned by the State, that are expected to become excess land, have recreation potential. The first site, located on the south-east quadrant of the proposed By-Pass and the River includes two parcels: one between Shields Lane (which connects to Rt. 273 at Christiana) and the river, equalling .6 of an acre, and a small .14-acre access across Shields Lane. The other site consists of 10.4 acres between Old Baltimore Pike and the River in the north-west quadrant of the By-Pass and the River. Although this second site will have no direct access to Old Baltimore Pike, there is a contiguous Delmarva Power facility with roadway access. A shared access between Delmarva and future public uses on the 10.4 acre state land could be planned, if Delmarva were agreeable, which would then allow recreational uses on the State owned site.

Obviously because of the respective sizes of these two sites, specific recreation use requirements will need to be more carefully evaluated. However, as far as recreational potential is concerned, these areas would be suitable for hiking, nature observation, and picnicking and as a launch area for canoes.

#### 4. Park Drive Site.

Within the City of Newark a portion of state land will become excess upon completion of the Newark Connector between Rt. 896 and Elkton Rd. (Rt. 2) that would have recreational potential. The area includes between 31.2 and 34.2 acres directly off of Park Drive, contiguous to the existing Rittenhouse Park along the Christina owned by the City of Newark. The site is located on both sides of the Christina and is suitable for the following recreational uses: hiking, picnicking, athletics, and camping.

## RECOMMENDATIONS

The following recommendations are provided as a means of realizing the potential of recreational activity on the Christina River. Moreover, it is believed that greater recreational opportunities can be made available, without large expenditures of capital improvement funds.

1. Site planning and design analyses should be undertaken for each of the sites with recreation potential, as identified in this study. The planning and design analysis would include recreational uses that are suitable for each site, as well as needed public access improvements, which will not require sizeable infrastructure or capital investments.
2. Since the river currently provides recreational activities for many--especially fishing, canoeing, and sailing--these activities could serve as the basis for a promotional effort to acquaint residents within the County of both existing and potential recreational activities.
3. A "historic colonial river tour" could be established to take advantage of tourism potential, for those traveling Interstate I-95 between Cooch's Bridge and the Village of Christiana. The colonial river tour could be an appropriate respite for long distance travelers who could get on or off I-95 at either Rt. 896 (near Cooch's Bridge) or Rt. 273 (near Christiana). The tour could include visiting the Cooch's Bridge Historic District and the Village of Christiana, and utilize points in between for relaxation, picnicking, casual walking, and possibly camping. Existing motel and restaurant facilities could provide overnight



and eating accomodations. In effect this recommendation could be implemented through a promotional campaign.

4. Since practically the entire length of the river has been nominated as a critical area by various units of government, it should be established as a State, County, and Municipal policy that further urbanization would be strictly regulated within a "River Corridor" to be defined as reserved for public recreation, conservation, and critical area protection. A County flood plain ordinance similar in scope to that enacted in the City of Newark could achieve this end.
5. As determined by the land based suitability analysis, the activity of bicycling can be conducted on many streets and roadways near the River. A Christina River bikeway system could be developed after a more in-depth evaluation of access points and a pattern of bike trails intersecting with public roadways could be signed for easy use. The proposed bicycle path, known as the Christina River Trail, could be extended along the Christina shoreline to the New Christiana By-Pass.
6. Although many roadway crossings of the Christina exist, direct public access to the Christina could be better achieved through signs or markings and improved roadway shoulders, on publicly owned land.

APPENDICES

## Appendix 1

## SHORELINE OWNERSHIP INVENTORY

Hundred	Map No.	Parcel No. -Bank	Size	Ownership
Wilmington City	67.00	003 (L)	149.00 ac.	City of Wilm. Harbor Board
	65.00	002 (R)	36.17 ac.	U.S.A.
	64.00	001 (R)	6.62 ac.	U.S.A.
	67.00	001 (L)	3.49 ac.	Mayor & Council of Wilmington
	63.00	016 (L)	28.60 ac.	Frederic A. Potts & Co., Inc.
	59.00	002 (R)	121.99 ac.	U.S.A.
	59.00	001 (R)	51.65 ac.	Mayor & Council of Wilmington
	63.00	011 (L)	8.70 ac.	Frederic A. Potts & Co., Inc.
	63.00	017 (L)	0.98 ac.	Frederic A. Potts & Co., Inc.
	58.00	019 (L)	22.69 ac.	DuPont Co.
	58.00	017 (L)	1.08 ac.	Mayor & Council of Wilmington.
	58.00	016 (L)	12.52 ac.	Delmarva Power & Light
	59.00	003 (R)	12.87 ac.	City of Wilmington
	51.00	022 (L)	50.93 ac.	Delmarva Power & Light
	51.00	023 (L)	2.22 ac.	Commerce St. Realty
	51.00	024 (L)	1.08 ac.	Commerce St. Realty
	52.00	007 (R)	11.68 ac.	Delmarva Power & Light
	52.00	003 (R)	6.80 ac.	City of Wilmington
	44.00	013 (R)	8.81 ac.	Fort Christina Marina Inc.
	44.00	012 (R)	4.95 ac.	First State Enterprises
	44.00	031 (R)	0.59 ac.	John R. Kaiser
	44.00	011 (R)	0.45 ac.	John R. Kaiser
	44.00	009 (R)	2.18 ac.	State of Delaware
	44.00	008 (R)	7.38 ac.	Wilson Marine Repair
	44.00	035 (R)	0.67 ac.	State of Delaware
	44.00	036 (R)	0.13 ac.	State of Delaware
	44.00	025 (L)	0.01 ac.	Mayor & Council of Wilmington
	44.00	024 (L)	0.72 ac.	Grnwd Corp. c/o Berg Boat Co.
	51.00	010 (L)	2.73 ac.	Four B's Realty Co.
	51.00	009 (L)	2.69 ac.	Edward Schneider & wife
	51.00	008 (L)	3.03 ac.	Saienni Bros. Blacktop Prod.
	51.00	007 (L)	0.79 ac.	Saienni Bros. Blacktop Prod.
	51.00	025 (L)	1.30 ac.	State of Delaware
	51.00	005 (L)	0.02 ac.	State Highway Department
	51.00	004 (L)	2.61 ac.	Diamond Industries Inc.
	51.00	003 (L)	3.81 ac.	Daromann Inc.
	51.00	001 (L)	16.87 ac.	Diamond Industries, Inc.
	44.00	004 (R)	11.19 ac.	City of Wilm. Harbor Board
	44.00	001 (R)	2.06 ac.	Rollins Outdoor Advertising Inc.
	50.00	040 (L)	0.74 ac.	Jess Auto Supply Inc.
	50.00	039 (L)	6.05 ac.	Delaware Humane Association
	50.00	038 (L)	1.55 ac.	Leonard Yermal & C. H. Tefke
	50.00	037 (L)	1.02 ac.	John Staeffler
	50.00	036 (L)	2.12 ac.	Henry W. Rutkowski & wife
	50.00	035 (L)	1.89 ac.	Frederic G. Krapf & sons
	50.00	032 (R)	8.43 ac.	Charles J. Lang
	50.00	034 (L)	1.05 ac.	William J. Maher Jr. & wife
	50 00	033 (L)	0.52 ac.	State of Delaware

Hundred	Map No.	Parcel No. -Bank	Size	Ownership
	50.00	009 (L)	1.77 ac.	Frederic G. Krapf & Sons
	50.00	008 (L)	1.24 ac.	Frederic G. Krapf & Sons
	50.00	006 (L)	1.03 ac.	Certified Concrete of Del.
	43.00	021 (R)	3.16 ac.	MCCar Corporation
	43.00	020 (R)	3.20 ac.	Zallea Brothers Inc.
	43.00	019 (R)	1.87 ac.	Wilco Realty Co. Inc.
	43.00	028 (R)	0.20 ac.	National Passenger Railroad Corp.
	43.00	015 (R)	1.36 ac.	Transportation Associates
	43.00	014 (R)	0.27 ac.	Transportation Associates
	43.00	013 (R)	1.07 ac.	P & P Enterprises Inc.
	43.00	007 (R)	1.02 ac.	B & O RR Co.
	43.00	006 (R)	0.98 ac.	B & O RR Co.
	43.00	005 (R)	0.85 ac.	Berger Company
	43.00	003 (R)	2.15 ac.	Wesley Realty Co.
	43.00	004 (R)	0.94 ac.	Equipment Clearing House
	43.00	002 (R)	2.93 ac.	State Dept. of Comm. Affairs & Eco.
	43.00	010 (L)	1.29 ac.	Thomas & Anita McBride
	43.00	009 (L)	0.48 ac.	City of Wilm. Water Department
	43.00	008 (L)	2.44 ac.	Samuels Realty Co.
	42.00	015 (L)	0.37 ac.	Delmarva Power & Light
	42.00	006 (R)	8.70 ac.	Delmarva Power & Light
	49.00	005 (R)	15.29 ac.	HUB Marine & Industrial
	49.00	003 (R)	3.93 ac.	Wilm. Ind. Realty Corp.
	49.00	006 (L)	0.01 ac.	George Mellon Jr. & wife
	49.00	007 (L)	5.00 ac.	H. Schwartz & sons
	49.00	008 (L)	1.92 ac.	Wallace Axselle
	49.00	009 (L)	5.50 ac.	Shellhorn & Hill
	49.00	010 (L)	2.58 ac.	Natalie Rita Gordon
	49.00	011 (L)	6.03 ac.	Shotmeyer Oil Co.
	49.00	012 (L)	2.09 ac.	James T. Collins
	49.00	013 (L)	4.29 ac.	William & Maxine C. Lamplugh
	49.00	014 (L)	5.18 ac.	State Dept. of Comm. Affairs & Eco.
	57.00	001 (L)	3.82 ac.	Elizabeth H. Walker
	57.00	002 (L)	3.18 ac.	VAPAT Inc.
	57.00	003 (L)	3.16 ac.	VAPAT Inc.
New Castle Hundred	1.00	062 (L)	1.67 ac.	Tire Sales and Service Inc.
	1.00	061 (L)	1.93 ac.	Tire Sales and Service Inc.
	1.00	002 (L)	1.62 ac.	Frederic G. Krapf Jr. & wife
	1.00	009 (L)	3.70 ac.	Irene Casper
	1.00	056 (L)	9.07 ac.	O'Brien Realty Corp.
	1.00	065 (L)	2.90 ac.	Delmarva Power & Light
	1.00	012 (L)	13.50 ac.	New Castle Historical Society
	1.00	013 (L)	15.10 ac.	Homer W. Booker Jr.
	8.00	001 (L)	43.66 ac.	DuPont Company
	8.00	002 (L)	21.64 ac.	Dominic A. Necastro
	8.00	010 (L)	5.06 ac.	Earl L. Vandenheuvell & wife
	8.00	011 (L)	7.94 ac.	Edward Crescenzo
	8.00	015 (L)	1.90 ac.	James & Susanne Baker
	8.00	016 (L)	1.84 ac.	B & F Towing and Salvage Co.
	8.00	017 (L)	1.76 ac.	Roland Hamilton & wife

Hundred	Map No.	Parcel No. -Bank	Size	Ownership
	8.00	018 (L)	1.73 ac.	Edward F. Klosowski & wife
	8.00	019 (L)	1.73 ac.	Allen J. & Johnnie Russell
	8.00	020 (L)	1.70 ac.	Genis Enterprises
	8.00	021 (L)	5.73 ac.	Delmarva Power & Light
	8.00	035 (L)	2.78 ac.	John R. Hardy
	8.00	025 (L)	3.29 ac.	Judson Goldsborough & wife
	8.00	026 (L)	1.92 ac.	J. Sutton Hamilton
	8.00	027 (L)	4.76 ac.	Horisks Salvage Pool Inc.
	8.00	037 (L)	4.69 ac.	Joseph T. & Bernice Morgan
	8.00	034 (L)	1.96 ac.	Edward & Daniel Waxman
	8.00	028 (L)	1.35 ac.	Delmarva Power & Light
	12.00	001 (L)	5.32 ac.	Sante & Aldine Volpe
	12.00	002 (L)	4.00 ac.	State Dept. of Comm. Aff. & Eco. Dev
	12.00	003 (L)	3.80 ac.	Edward & Pat Breitenbach
	13.00	003 (L)	26.49 ac.	State of Delaware
	12.40	017 (L)	5.81 ac.	William J. McKinney
	12.40	018 (L)	2.00 ac.	Raymond L. & Theresa C. Rash
	12.40	019 (L)	2.09 ac.	Raymond Cathell & wife
	12.40	020 (L)	1.96 ac.	Theodore Grunza
	12.40	021 (L)	1.65 ac.	Anthony F. Ruggiero & wife
	12.40	022 (L)	4.00 ac.	William R. Jr. & Darlyn Reed
	12.40	055 (L)	1.33 ac.	William R. Jr. & Darlyn Reed
	12.40	023 (L)	1.32 ac.	William R. Jr. & Darlyn Reed
	12.40	024 (L)	1.31 ac.	James T. Dailey & wife
	12.40	025 (L)	2.16 ac.	Albert A. Donofrio & wife
	12.40	026 (L)	1.12 ac.	Charles G. Ryan Jr. & wife
	12.40	027 (L)	2.46 ac.	Myron J. Long
	12.40	011 (L)	1.02 ac.	Herlel Corp.
	12.40	012 (L)	0.92 ac.	Herlel Corp.
	12.40	013 (L)	0.84 ac.	Herlel Corp.
	12.40	014 (L)	2.53 ac.	John E. Steele & wife
	12.40	015 (L)	2.47 ac.	Conrad A. Rexroad & wife
	12.40	001 (L)	4.00 ac.	Conrad A. Rexroad & wife
	12.40	002 (L)	1.30 ac.	Michael L. Maiorano
	12.40	054 (L)	1.15 ac.	George A. Maiorano & wife
	12.40	059 (L)	1.00 ac.	Paul Sr. & Joyce Fitzwater
	12.40	003 (L)	0.86 ac.	Clarence L. & Eleano Sheats
	17.20	001 (L)	0.73 ac.	Clarence L. & Eleano Sheats
	17.20	002 (L)	0.66 ac.	Mary Chambers
	17.20	003 (L)	0.61 ac.	Woodrow Chambers
	17.20	004 (L)	0.53 ac.	George P. Eleckho & wife
	17.20	005 (L)	1.08 ac.	Joseph G. Marinari & wife
	17.00	001 (L)	1.10 ac.	State of Delaware
	17.00	002 (L)	3.80 ac.	Arthur C. Lamborn & wife
	17.00	003 (L)	18.54 ac.	Mildred L. Sannit, et. al.
	17.00	004 (L)	31.86 ac.	Moore Brothers Inc.
	17.00	005 (L)	40.00 ac.	State of Del.--Division of Motor Veh
	17.30	001 (L)	28.58 ac.	Levy Court of New Castle County
	23.10	001 (L)	12.06 ac.	State of Delaware
	23.00	001 (L)	44.40 ac.	Levy Court of New Castle County

Hundred	Map No.	Parcel No. -Bank	Size	Ownership
	23.00	009 (L)	1.39 ac.	New Castle County
	28.00	025 (L)	85.82 ac.	New Castle County
	28.00	041 (L)	4.58 ac.	New Castle County
	28.00	001 (L)	18.25 ac.	Rachel P. Justis
	28.00	006 (L)	1.85 ac.	James E. Broomall & wife
	28.00	007 (L)	2.61 ac.	State of Delaware
	28.00	020 (L)	43.85 ac.	State of Delaware
	28.30	243 (L)	57.17 ac.	Rivers End Inc.
	32.00	001 (L)	24.87 ac.	Wilmington Suburban Water Co.
1 This parcel has been divided into indivi- dual lots-Taylortowne.	32.00	002 (L)	173.38 ac.	Smalley's Dam Venture Inc.
	38.00	001 (L)	121.12 ac.	Whittington Sand & Gravel
	43.00	003 (L)	120.19 ac.	Abram P. Fox & wife
	43.00	002 (L)	32.29 ac.	Delmarva Power & Light
	38.30	001 (L)	38.62 ac.	James P. Brennan--Trustee
	38.30	182 (L)	1.09 ac.	J & A Properties Inc.
Christiana Hundred	42.00	001 (L)	16.88 ac.	William Saienni & wife
	44.10	002 (R)	11.69 ac.	Wilmington Ind. Realty Corporation
	44.10	003 (R)	56.12 ac.	HUB Marine and Ind.
	44.10	004 (R)	14.32 ac.	Delmarva Power & Light
	43.40	055 (R)	130.00 ac.	New Castle County
	48.10	001 (R)	4.52 ac.	New Castle County
	47.20	416 (R)	30.94 ac.	New Castle County
	47.40	006 (R)	11.49 ac.	Edgar T. & Thetis R. Harvey
	47.30	108 (R)	47.15 ac.	DuPont Company
	46.40	310 (R)	317.10 ac.	DuPont Company
Newport Town	04.00	030 (R)	3.22 ac.	Edgar T. & Thetis R. Harvey
	04.00	033 (R)	0.34 ac.	Edgar T. Harvey
	04.00	021 (R)	23.62 ac.	Commissioners of Newport
	04.00	020 (R)	19.35 ac.	Howard P. Wilson
	04.00	019 (R)	1.09 ac.	DuPont Company
	04.00	017 (R)	0.49 ac.	DuPont Company
	03.00	090 (R)	0.26 ac.	John J. Cassidy Jr. & wife
	03.00	089 (R)	0.19 ac.	Albert L. Freeman & wife
	03.00	088 (R)	0.11 ac.	DuPont Company
	03.00	087 (R)	0.11 ac.	Rachel P. Justis
	03.00	086 (R)	0.11 ac.	State of Delaware
	03.00	096 (R)	0.39 ac.	State of Delaware
	03.00	084 (R)	0.20 ac.	Delmarva Power & Light
	03.00	083 (R)	9.10 ac.	DuPont Company
White Clay Creek	19.00	032 (R)	515.77 ac.	Artesian Water Co.
	25.10	095 (R)	44.69 ac.	Capano Development Co.
	24.00	013 (R)	152.51 ac.	Cavaliers of Delaware Inc.
	24.00	014 (R)	142.64 ac.	F. E. and Maria A. H. Acierno
	30.00	082 (R)	243.85 ac.	Albert H. Marta, et. al.
	30.00	080 (R)	14.60 ac.	State of Delaware
	30.30	047 (R)	1.47 ac.	Jacob L. Green & wife
	30.30	083 (R)	0.25 ac.	State of Delaware
	30.30	082 (R)	0.18 ac.	John E. Adamson
	30.30	081 (R)	0.62 ac.	Edward J. Gordon 3d & wife
	30.30	067 (R)	0.62 ac.	John Gadomski & wife

Hundred	Map No.	Parcel No. -Bank	Size	Ownership
<sup>2</sup> This parcel has been subdivided into two parcels, 58.99 ac. and 19.46 ac.-- Wilmington Suburban Water Corp.	30.30	064 (R)	1.07 ac.	Lillie E. Baker
	30.30	063 (R)	2.45 ac.	Lloyd B. Baker & wife
	35.10	003 (R)	0.78 ac.	Alwin F. & Dorothy T. Archer
	35.10	004 (R)	1.74 ac.	Roy J. Musser & wife
	35.10	005 (R)	3.48 ac.	Lela G. Cleaver
	35.00	012 (R)	20.97 ac.	State of Delaware
	35.00	011 (R)	7.88 ac.	State of Delaware
	35.00	014 (R)	21.45 ac.	Delmarva Power & Light
	34.00	037 (R)	278.45 ac.	Wilmington Suburban Water Corp.
	34.00	026 (R)	0.04 ac.	Ann B. Hutson
	34.00	027 (R)	0.09 ac.	Alan R. Gregor
	34.00	028 (R)	5.09 ac.	Ann B. Hutson
	38.00	042 (R)	29.63 ac.	Delaware Canoe Club
	38.00	043 (R)	12.00 ac.	Marvin & Anna Hershberger
	38.00	044 (R)	107.41 ac.	Eastern States Construction Co.
	41.00	005 (R)	46.29 ac.	Charles A. Walther Jr.
	41.00	002 (R)	105.85 ac.	Associated Capitol Inv. Inc.
	41.00	009 (R)	8.82 ac.	Frank E. Acierno
	41.00	010 (R)	8.82 ac.	Frank E. Acierno
	40.00	018 (R)	37.64 ac.	Frank E. Acierno
	40.00	016 (R)	138.13 ac.	A. Gray & Donald L. Magness
	37.30	017 (R)	12.18 ac.	Pierce Builders Inc.
	37.00	017 (R)	6.42 ac.	Charles W. Mullins
	37.00	013 (R)	8.14 ac.	Clarence S. Reed Jr.
	37.00	010 (R)	77.13 ac.	Edgar T. Harvey Jr. & wife
	36.00	006 (R)	60.59 ac.	Jesse E. Gorman & wife
	39.00	001 (R)	21.88 ac.	Vernon Comly & wife
	26.00	002 (L-R)	39.09 ac.	Edward C. Wilson & wife
	26.00	003 (L-R)	7.21 ac.	Arthur P. Mayer & wife
	26.00	001 (L)	45.74 ac.	DuPont Company
	20.10	018 (L-R)	1.60 ac.	W. Eugene Renn & wife
	13.00	046 (L)	1.57 ac.	Charles K. Skinner
	13.00	042 (L)	2.59 ac.	David E. Lamb & wife
	13.00	043 (L-R)	3.08 ac.	William J. Lawler
	13.00	041 (L-R)	158.60 ac.	Ates-Kay Company
	07.30	039 (R)	1.61 ac.	Emily M. Eppes
	07.30	038 (R)	0.76 ac.	Val E. Arnsdorf & wife
	07.30	037 (R)	1.01 ac.	Emmett J. Conte Jr. & wife
	07.30	036 (R)	3.81 ac.	Alvin L. Acker Jr. & wife
	07.30	035 (R)	1.00 ac.	Bridle Brook Inc.
	07.30	034 (R)	1.12 ac.	Christopher C. & Mary Mench
	07.30	033 (R)	1.10 ac.	David W. & Helen St. Clair
	07.30	032 (R)	0.94 ac.	Raymond K. Arzinger & wife
	07.30	031 (L-R)	0.91 ac.	George J. & Mabel C. W. Henry
	07.30	030 (L)	0.93 ac.	Bridle Brook Inc.
Pencader Hundred	19.00	006 (L)	3.93 ac.	James F. Beckley & wife
	19.00	005 (L)	8.57 ac.	James P. Brennan & wife, et. al.
	15.00	001 (L)	196.35 ac.	Donald L. and Gray A. Magness
	14.00	073 (L)	161.60 ac.	John A. Sniadowski, et. al.
	14.00	066 (L)	29.10 ac.	Delmarva Power & Light

Hundred	Map No.	Parcel No. -Bank	Size	Ownership
Newark City		14.00 054 (L)	2.00 ac.	State of Delaware
		14.00 051 (R)	52.44 ac.	Vernon Comly
		14.00 043 (L)	82.09 ac.	Delmarva Power & Light
		14.00 080 (R)	2.65 ac.	Bruce F. Harvey
		14.00 044 (L-R)	33.97 ac.	Dayett Mills Inc.
		10.00 009 (L-R)	229.19 ac.	Edward W. Cooch, Jr.
		09.00 035 (R)	0.37 ac.	John H. Jr. & Elnora Davis
		09.00 032 (L)	37.43 ac.	Trustees of Welsh Tract Bap. Church
		09.00 034 (L)	1.72 ac.	William P. & Virginia Wegman
		04.00 023 (L)	16.73 ac.	Manor Real Estate Co.
		01.00 001 (L)	105.44 ac.	Pauline A. Mayer Inc.
		01.00 007 (L-R)	8.06 ac.	Perry L. Munday & wife
		47.00 005 (R)	11.39 ac.	F. Schumacher & Co.
		46.00 037 (R)	0.39 ac.	Charles A. & Rebecca Weber
		46.00 036 (R)	0.45 ac.	William Trush & wife
		46.00 035 (R)	0.62 ac.	Cloyce H. Heegard & wife
		46.00 034 (R)	0.49 ac.	William J. Clancy 3d & wife
		46.00 033 (R)	0.74 ac.	Benjamin J. Southman & wife
		46.00 032 (R)	1.15 ac.	Bryon N. Baer & wife
		46.00 030 (R)	0.92 ac.	Eugene L. Frazee & wife
		46.00 029 (R)	1.38 ac.	Samuel L. Dowell & wife
		46.00 028 (R)	1.90 ac.	Alexander Botluck & wife
		46.00 024 (R)	3.36 ac.	Colando Corp.--Joe Martin
		46.00 094 (R)	0.78 ac.	James F. Wood Jr. & wife
		44.00 074 (L)	2.02 ac.	City of Newark
		44.00 078 (R)	5.40 ac.	Benson Associates
		44.00 075 (L)	2.30 ac.	Benson Associates
		44.00 076 (R)	1.90 ac.	Newark Land Inv. Co.
		44.00 020 (R)	0.35 ac.	John S. Coates
		44.00 019 (R)	0.46 ac.	Patricia R. Rockwell
		44.00 018 (R)	0.50 ac.	Stanley W. Smith & wife
		44.00 017 (R)	0.48 ac.	Robert E. Snyder & wife
		43.00 139 (L-R)	43.71 ac.	City of Newark
		43.00 138 (L)	4.99 ac.	City of Newark
		39.00 004 (L-R)	34.29 ac.	State of Delaware
		39.00 003 (L-R)	1.83 ac.	City of Newark
		38.00 001 (L-R)	39.02 ac.	Manor Real Estate Co.
		34.00 053 (R)	8.50 ac.	Manor Real Estate Co.
		34.00 050 (R)	15.01 ac.	Pauline A. Mayer Inc.
		23.00 032 (L)	19.72 ac.	Mortgage Investors of Washington
		23.00 033 (L-R)	4.52 ac.	City of Newark
		23.00 034 (R)	11.44 ac.	Catherine R. Williams, et. al.
		23.00 030 (L-R)	10.56 ac.	City of Newark
		18.00 058 (R)	12.09 ac.	Board of Ed.--Newark Special School D
		18.00 432 (L)	2.10 ac.	City of Newark
		12.00 279 (L-R)	14.71 ac.	City of Newark
		12.00 102 (R)	0.24 ac.	Larry W. Martin & wife
		12.00 101 (R)	0.24 ac.	Thomas C. Maddux & wife
		12.00 100 (R)	0.23 ac.	Edward J. Guringo & wife
		12.00 099 (R)	0.22 ac.	H. James Dobbs



Hundred	Map No.	Parcel No. -Bank	Size	Ownership
	12.00	098 (R)	0.26 ac.	Trevor N. Jr. & Linda Dupuy
	12.00	096 (R)	0.26 ac.	Lillian Grant
	12.00	095 (R)	0.25 ac.	George B. Marline Jr. & wife
	12.00	087 (R)	0.59 ac.	Harry P. Graham & wife
	06.00	010 (R)	0.36 ac.	Lester C. Gerard Jr. & wife
	06.00	011 (R)	0.43 ac.	City of Newark

(L) indicates the left bank and (R) indicates the right bank of the river travelling upstream

Source: Real Estate Atlas of New Castle County, Delaware. (Seventh Edition: 1980)  
Miami, Florida: Real Estate Data, Inc.

## Appendix 2

### WATER QUALITY TECHNICAL ANALYSIS

#### Water Quality Standards

The Delaware Department of Natural Resources and Environmental Control (DNREC) has established standards for rivers and streams to meet water quality goals. The water quality guidelines used in developing standards is stated as follows:

It is the policy of the State to maintain within its jurisdiction a reasonable quality of water consistent with public health and public recreation purposes, the propagation and protection of fish and wildlife, including birds, animals, and all other terrestrial and<sup>1</sup> aquatic life, as well as the industrial development of the State.

The official Delaware stream quality standards are provided in Table A-1 and do not differentiate among various water uses such as swimming and fishing.

Table A-1

#### DELAWARE WATER QUALITY STANDARDS

Criterion	Standard
Water Temperature	for coastal and estuarine waters: 85°F, with no rise of greater than 4°F from September to May or 1.5°F from June to August  for non-tidal streams: 85°F, no rise of greater than 5°F
dissolved oxygen	non-tidal portions: daily average 5mg/l, minimum 4mg/l tidal portions: daily average 6mg/l, minimum 5mg/l
turbidity	for coastal and estuarine waters: monthly average 40 JTU, maximum 150 JTU  for non-tidal streams: not to exceed natural background by more than 10 JTU, maximum 25 JTU
suspended solids	less than 25mg/l for maximum protection of aquatic life  less than 80mg/l for moderate protection of aquatic life

<sup>1</sup>Water Quality Standards For Streams, DNREC (1979).

Table A-1 continued

Criterion	Standard	
fecal coliform	maximum log mean 200 col./100 ml	
total coliform	70 per 100 ml/median; not more than 10% of all samples may exceed 230/100 ml	
pH	6.5 to 8.5	
total alkalinity	not less than 20 mg/l as $\text{CaCO}_3$	
total acidity	not to exceed alkalinity by 20 mg/l at any time	
alpha emitters	maximum 3 pc/l	
beta emitters	maximum 1000 pc/l	
phenolic compounds	non-tidal portions: .01 mg/l tidal portions: .005 mg/l	
toxic substances	DDT: .001 ug/l Aldrin: .003 ug/l Dieldrin: .003 ug/l Toxaphene: .005 ug/l	PCB's: .001 ug/l Benzidine: 0.1 ug/l Endrin: 0.2 ug/l
ammonia N	not to exceed .4 mg/l	
total N	not to exceed 3.0 mg/l	
total dissolved solids	not to exceed 250 mg/l of which the sulfate portion may not exceed 100 mg/l	
fluorides	.2 mg/l	

Source: Delaware Department of Natural Resources and Environmental Control.  
Delaware 1980 Water Quality Inventory.

Although these standards will be used as the basis for water quality analysis of the Christina, it should be noted that certain water uses require higher standards. For example, the Delaware River Basin Commission has developed standards for dissolved oxygen content in fishable waters. The minimum requirements are a seasonal average of 6.5 mg/l and a minimum at one time of 4.0 mg/l. The recommended minima are 5.0 mg/l for the summer season and 6.0 mg/l for the spring season.<sup>2</sup>

#### Water Quality Assessment

The Delaware 1980 Water Quality Inventory, reporting the findings of the 1979 sampling program, indicates that water quality of the Christina River is improving. On the Lower Christina, all stations showed improvement since 1977, with respect to dissolved oxygen, total nitrogen, organic nitrogen, ammonia nitrogen, nitrite nitrogen, pH, lead, copper, nickel, manganese, and zinc. However, levels of fecal coliform bacteria showed no improvement since 1977, and 2 stations were over State and EPA limits.<sup>3</sup> Point source discharges had also decreased sharply. On the Upper Christina, however, only slight improvements in water quality were observed since 1977. Saturation of dissolved oxygen and gross amount of dissolved oxygen had increased and these factors were rarely a problem. No readings were in violation of state standards. Some metals concentrations improved, though the Upper Christina was judged to have low assimilative capacity and problems with fecal coliform bacteria were observed, especially in the northern areas.<sup>4</sup>

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<sup>2</sup> Dissolved Oxygen Requirements of a "Fishable" Delaware River Estuary, Ad-Hoc Task Force to Evaluate Dissolved Oxygen Requirements of Indigenous Estuary Fish. Report to the Delaware River Basin Commission. 1979.

<sup>3</sup> DNREC, Delaware 1980 Water Quality Inventory; p. 69.

<sup>4</sup> Ibid.; p. 71.

The DNREC Technical Services Division has made available for this study the results of the 1980 water quality sampling, which were used in the detailed water quality assessments.

Tables A-2 through A-5 show the results of the sampling at 11 locations on the Christina for each of the four yearly seasons. These results were then compared with the State Water Quality Standards for Streams. It should be noted that some criteria were cited as being in violation even if the result is within the standards. Although the seasonal average may not be in violation, a violation was recorded at a particular point in time.

Table A-2

## WATER QUALITY SAMPLING-WINTER

Christina River

## Sampling Stations

Criteria	Third St. Bridge	Route 41	Smalley's Pond Dam	Walther Road	Salem Ch. Rd.	Route 72	Old Balt. Pk.	Chestnut Hill Rd.	Persimmon Run	Elkton Road	Nottingham Road
Dissolved oxygen (mg/l)	13.1	14.1	14.3	13.6	13.1	13.3	15.0	15.3	13.8	14.7	14.6
pH	7.2	7.2	7.2	7.0	7.6	6.8	6.9	6.9	6.9	6.8	7.1
Alkalinity (mg/l as CaCO <sub>3</sub> )	44.7	46.5	22.3	22.0	17.7*	18.0*	28.0	25.0	21.3*	24.0	20.5
Acidity (mg/l as CaCO <sub>3</sub> )	5.0	4.5	4.7	5.5	4.5	5.5	8.0	4.5	6.3	5.0	5.5
Fecal coliform bacteria (colonies/100ml)	623.3*	125.0	50.0	20.0	10.0	25.0	30.0	20.0	10.0	15.0	120.0
Turbidity (units)	16.7	7.5	7.0	7.0	13.0	15.0*	4.0	2.5	3.0	2.0	1.5
Ammonia N (mg/l)	.48*	.12	.13	.10	.11	.10	.20	.20	1.73*	.10	.10
Total N (mg/l)	.98	.65	.45	.55	.35	.65	.50	.45	2.0	.25	.40
Total Violations	2	0	0	0	1	2	0	0	2	0	0

\*-violation

Source: DNREC Technical Services Division

Table A-3

## WATER QUALITY SAMPLING-SPRING

Christina River

## Sampling Stations

Criteria	Third St. Bridge	Route 41	Snalley's Pond Dam	Walther Road	Salem Ch. Rd.	Route 72	Old Balt. Pk.	Chestnut Hill Rd.	Persimmon Run	Elkton Road	Nottingham Road
Dissolved oxygen (mg/l)	9.3	10.4	9.6	9.2	9.4	9.1	10.2	10.8	9.3	10.6	11.0
pH	7.1	7.3	7.2	7.1	7.1	7.1	7.3	7.3	7.1	7.2	7.2
Alkalinity (mg/l as CaCO <sub>3</sub> )	46.3	48.7	36.7	36.7	30.7*	32.0*	38.0	40.0	35.7	37.3	36.3
Acidity (mg/l as CaCO <sub>3</sub> )	4.3	3.0	3.0	3.3	3.3	4.0	3.3	2.7	4.0	3.3	2.7
Fecal coliform bacteria (colonies/100ml)	523.3*	730.0*	56.7	176.7	1570.0*	100.0	3126.7*	136.7	46.7	313.3*	216.7*
Turbidity (units)	11.7	16.7	11.7	8.3	23.3*	11.7	4.5	3.7	4.5	2.3	2.0
Ammonia N (mg/l)	.17	.18	.13	.11	.11	.10	.25*	.10	.82*	.11	.10
Total N (mg/l)	1.47	1.42	1.27	1.41	1.55	0.63	2.42*	1.00	1.77	0.55	0.36
Total Violations	1	1	0	0	3	1	3	0	1	1	1

\*-violation

Source: DNREC Technical Services Division

Table A-4

## WATER QUALITY SAMPLING-SUMMER

Christina River

Sampling Stations

Criteria	Third St. Bridge	Route 41	Snalley's Pond Dam	Walther Road	Salem Ch. Rd.	Route 72	Old Balt. Pk.	Chestnut Hill Rd.	Persimmon Run	Elkton Road	Nottingham Road
Dissolved oxygen (mg/l)	5.0*	7.2	6.0*	6.0	7.1	4.9*	5.5	8.6	7.0	8.1	8.8
pH	7.5	7.3	7.4	7.4	7.4	7.4	7.3	7.5	7.2	7.3	7.4
Alkalinity (mg/l as CaCO <sub>3</sub> )	52.3	58.7	38.0	36.7	24.0	41.0	45.3	38.0	36.5	36.7	33.5
Acidity (mg/l as CaCO <sub>3</sub> )	4.7	4.3	4.7	4.3	3.5	4.0	4.0	6.0	4.5	3.3	4.0
Fecal coliform bacteria (colonies/100ml)	826.7*	360.0*	220.0*	293.3*	35.0	75.0	5913.3*	170.0	275.0*	343.3*	270.0*
Turbidity (units)	10.0	12.0	10.0	7.5	5.5	8.5	8.3	8.5	8.5	4.5	5.0
Ammonia N (mg/l)	.13	.11	.10	.15	.48*	.10	.73*	.10	.10	.20	.10
Total N (mg/l)	.83	.92	.67	.82	1.53	1.20	2.20*	2.20	1.00	.93	.95
Total Violations	2	1	2	1	1	1	3	0	1	1	1

\*-violation

Source: DNR Technical Services Division



Table A-5

## WATER QUALITY SAMPLING-AUTUMN

Christina River

## Sampling Stations

Criteria	Third St. Bridge	Route 41	Snalley's Pond Dam	Walther Road	Salem Ch. Rd.	Route 72	Old Balt. Pk.	Chestnut Hill Rd.	Persimmon Run	Elkton Road	Nottingham Road
Dissolved oxygen (mg/l)	9.5	11.2	10.1	10.1	10.2	8.8	10.5	12.2	9.4	12.0	
pH	7.0	7.2	7.4	7.3	7.3	7.2	7.1	7.2	7.0	7.1	
Alkalinity (mg/l as CaCO <sub>3</sub> )	49.7	45.0	29.0	31.0	17.5*	31.0	35.7	33.7	40.0	32.7	
Acidity (mg/l as CaCO <sub>3</sub> )	8.0	5.0	4.7	6.3	6.5	4.0	4.7	4.7	9.0	5.3	
Fecal coliform bacteria (colonies/100ml)	686.7*	6166.7*	196.7	106.7	30.0	135.0	116.7	93.3	270.0*	130.0	
Turbidity (units)	18.3*	18.3*	11.7	7.7	5.0	10.0	5.0	17.3*	10.0	3.0	
Ammonia N (mg/l)	.50*	.20*	.26*	.16	.20	.15	.11	.13	.28*	.10	
Total N (mg/l)	1.30	.93	.90	.73	.70	.65	.75	.70	.90	.53	
Total Violations	2	3	1	0	1	0	0	1	2	0	

\*-violation

Source: DNREC Technical Services Division

SELECTED REFERENCES

#### SELECTED REFERENCES

C. J. O'Donnell, F. R. Selby, and William J. Cohen, Background Information: Delaware Urban Waterfront Project, (William J. Cohen and Associates, Inc.) prepared for the Delaware Office of Management, Budget, and Planning (1979).

New Castle County Areawide Waste Treatment Management (208) Program, Capability Mapping as a Means of Improving Environmental Quality: Prerequisites and Methods, (1977).

Cherry Island Urban Design Study, Philadelphia, PA: University of Pennsylvania, (1969).

Joachim Tourbier, The Christina Basin: The Protection of Water Resources as a Basis for Planning In Developing Areas, University of Delaware: Water Resources Center (N. D.).

New Castle County Department of Planning, Christiana Preservation Plan, (1977).

J. Tourbier, "The Christina Project--Environmental Protection in Urban Growth Areas." Urban Land (September 1972).

City of Newark, Delaware, Planning Department, Christina River Property and Natural Features Survey (1977).

W. Cohen and J. Hall, Christina River Stream Valley Guidelines for Acquisition and Financing, Newark, Delaware, Planning Department (1977).

Kendree and Shepherd Planning Consultants. City of Newark Comprehensive Development Plan Volume II. Philadelphia, Pennsylvania: Kendree and Shepherd, (1969).

Delaware Office of Management, Budget, and Planning. Delaware Coastal Management Program and Final Environmental Impact Statement (1979).

A. L. Strong, S. Slade, F. Crawford, P. Tabas. Delaware Law and Potential Land Use and Performance Controls for the Christina Basin. University of Delaware, Water Resources Center (1972).

Division of Historical and Cultural Affairs, Delaware Preservation Checklist (1974).

C. A. Weslager, Delaware's Forgotten River: The Story of the Christina (Wilmington: Hambleton, Inc., 1947).

Delaware Department of Natural Resources and Environmental Control, Delaware Statewide Comprehensive Outdoor Recreation Plan (1979).

Delaware 1980 Water Quality Inventory, DNREC (1980).

Ad-Hoc Task Force to Evaluate Dissolved Oxygen Requirements of Indigenous Estuary Fish, Dissolved Oxygen Requirements of a "Fishable" Delaware River Estuary. Report to the Delaware River Basin Commission (1979).

Richard C. Reichard, "Distribution of American Shad and Other Anadromous Species in the Tributaries of the Delaware River Basin." Delaware River Basin Anadromous Fishery Project Completion Report (1979).

Delaware Department of Natural Resources and Environmental Control, Draft, Delaware River Heritage System. [To be Chapter 74 of the laws of the State of Delaware] (1981).

E. Babig, Draft of Recreational Survey Model for Delaware, Delaware Nature Education Society (1980).

U. S. Army Corps of Engineers, Flood Plain Information Christina River (Christiana Acres to Cooch's Bridge), Muddy and Belltown Runs New Castle County, Delaware (1968).

U. S. Army Corps of Engineers, Flood Plain Information Christina River (Delaware River to Christiana Acres), Wilmington; New Castle County, Delaware (1970).

New Castle County Department of Planning, The Greater Newark Planning District Plan, 1985 (1974).

U. S. Army Corps of Engineers, "List of Navigable and Non-navigable Waterways in the Philadelphia District." (1972).

N. Bigelow, A Literary Search for the Christina Basin Project, University of Delaware, Water Resources Center (1972).

New Castle County Department of Planning, The Lower Christina Planning District Plan, 1985. (1974).

P. Seidenstat, The Market for Water Based Outdoor Recreation Service in New Castle County, Delaware. Newark, Delaware: University of Delaware, Water Resources Center (1966).

Kinsey Associates "Master Development Plan: Coventry Ridge/Lewden Green Park [Christina]", prepared for New Castle County Department of Parks and Recreation (1974).

K. R. Demars and R. Richards, Jr., et. al., Mill on the Christina: A Historic Engineering Study of the Dayett Mill Complex, University of Delaware Department of Civil Engineering (1980).

National Urban Recreation Study: Philadelphia-Wilmington-Trenton Area. Washington, DC: Bureau of Outdoor Recreation (1977).

New Castle County Department of Planning, New Castle County Bikeway Plan (1979).

R. Agnello, L. Donnelley, and R. Kirk, New Castle County Delaware River Shoreline Study, University of Delaware Department of Economics and College of Marine Studies (1977).

Department of Natural Resources and Environmental Control. New Castle County Natural Areas Study (1975).

New Castle County Department of Planning, Natural Physical Characteristics. A County Comprehensive Development Plan Background Study (1967).

M. Stanton, New Castle County Stream Use Survey, Water Resources Agency for New Castle County (1979).

New Castle County Department of Planning, The New Castle County--Upper Christina Planning District Plan, 1985 (1974).

B. Coston and J. Tourbier, Open Space Controls for the Protection of Water Resources in the Christina River Basin. Univeristy of Delaware, Water Resources Center (1972).

New Castle County Department of Planning, Parks and Recreation Areas, A County Comprehensive Development Plan Background Study (1967).

City of Wilmington Planning Department, A Pilot Plan for Wilmington's In-Town Riverfront (1979).

U. S. Department of Agriculture Forest Service, Proceedings: River Recreation Management and Research Symposium. General Technical Report New Castle - 28. North Central Forest Experiment Station (1977).

S. O'Byrne and P. Thompson, Project R. O. W., Cityside, Inc. (1981).

R. K. Turner, "The Recreational Response to Changes in Water Quality: A Survey and Critique." International Journal of Environmental Studies, (Volume 11, 1977).

W. J. Cohen and C. J. O'Donnell, Redevelopment Potential of the Delaware Urban Waterfront (William J. Cohen and Associates, Inc.), prepared for the Delaware Office of Management, Budget, and Planning (1979).

Report of the Delaware Tomorrow Commission (1976).

Report of the Governor's Task Force on Marine Recreation (1980).

Scott J. Beck and Victor J. Schuler, "A Report on Fishes, With Special Reference to Anadromous Species, Taken in Sampling During and After Hydraulic Dredging in the Vicinity of the Wilmington Maine Terminal During April through June 1976." Prepared for the Corps of Engineers, Philadelphia District. Ithaca, New York: Ichthyological Associates, Inc. (1976).

A Review of Institutional and Legal Aspects of Water Supply Policies in Delaware, Part Two (Dover, DE: Department of Natural Resources and Environmental Control (1979).

B. Kraeuter, Reivew of Non-Domestic Point Source Discharges, New Castle County Areawide Waste Treatment Management Program (1976).

A. Demetriou and Linton and Company, Riverfront Study for Wilmington, Delaware. Prepared for the Wilmington Department of Planning and Development, Two Volumes (1977).

U. S. Department of Agriculture, Soil Conservation Service, Soil Survey, New Castle County (1970).

Roy W. Miller, A Survey on Freshwater Fishing in Delaware. Delaware Division of Fish and Wildlife (1978).

Urban Route Bicycle System, City of Newark. City of Newark Planning Department (1973).

Department of Natural Resources and Environmental Control. Water Quality Standards for Streams (1970).

